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MUHAMMAD ATHER ELAHI

ESSAYS ON FINANCIAL FRAGILITY

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MUHAMMAD ATHER ELAHI

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Promotores:	prof. dr. Hans Degryse
	dr. María Fabiana Penas
Promotiecommissie:	dr. Fabio Castiglionesi
	dr. Olivier De Jonghe
	dr. Iman van Lelyveld
	prof. dr. Wolf Wagner

To Sabahat, Arham, Raiyan and Alishba

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Contents

1 INTRODUCTION OF THE THESIS

A number of financial crises started as an idiosyncratic shock to local banks, local securities or local markets, but the impacts eventually spread to markets with no direct economic linkage to the initial shock (e.g., the Mexican crisis in 1982 and 1994, the East Asian crisis in 1997, the Russian crisis in 1998, and the Brazilian crisis in 1999). Similarly, the financial turmoil that started in the summer of 2007 and intensified in 2008 as a local problem to the US-mortgage market has become a global concern for financial stability. These concerns are shared equally among policy makers in developed as well as in emerging market economies. Financial crises have also attracted the interest of researchers who empirically and theoretically study how local turmoil may spill over to international markets and investigate what the consequences are on regional financial fragility.

Banks are important because the instability of the banking sector may have severe financial costs to the economy. Hoggarth, Reis and Saporta (2002) for example estimate fiscal costs incurred in the resolution of 24 banking crisis in the last two decades and find that the cumulative output losses incurred during crisis periods are 15-20%, on average, of annual GDP. Further, banking system fragility impairs the functioning of the payment system that may ultimately lead to economic stagnation (Demirgüç-Kunt and Detragiache (1997)). A fragile banking system affects neighboring countries in the region through cross-border linkages and raises concerns for regional banking system fragility. Banks provide liquidity to the whole economy just like blood circulating in veins of the whole human body. The crisis in a banking sector has serious effects on other sectors of the domestic economy and possibly also for other economies in the same region and other regions. Therefore, it is important to study regional banking system fragility from an intra-industry and inter-industry contagion perspective.

Further, the integration of financial markets across regions has resulted into a higher degree of co-movements in financial stock indices. This phenomenon persuades researchers to study contagion not only through direct exposures (for example, Degryse, Elahi and Penas (2010) or the third chapter of this dissertation), but also through the co-movements of financial stock indices (for example, Bae, Karolyi and Stulz (2003); Gropp, Duca and Vesala (2009)). These studies limit their analysis either to general financial indices or to the same industry (i.e. intra-

industry contagion). But there is very little evidence on the effects of shocks that are transmitted from one industry to another (i.e. inter-industry contagion) or from one part of an industry to another part of an industry. Inter-industry contagion within the broader financial sector is important because financial liberalization has blurred the distinction between various types of financial activities. Resultantly, the emergence of financial conglomerates may induce contagion from one industry to another.

The thesis provides an insight of the regional fragility of the banking systems and the potential of cross-border contagion. After this brief introduction of the thesis as chapter 1, chapter 2 give a short review of literature on financial contagion through cross-border banking exposures, chapter 3 explores the possibility of cross-border contagion through direct exposures of the banking systems on other economies, chapter 4 investigates the determinants of regional banking system fragility and chapter 5 provides evidence on the inter-industry contagion within and across regions.

More specifically, in chapter 2, titled "Short Literature Review on Financial Contagion through Cross-Border Exposures" I provide a short review of the literature on financial contagion, and in particular of the role and impact of cross-border exposures. The issue of cross-border contagion is highlighted in particular. The importance of cross-border contagion stems from different forces. First, in recent years, foreign claims held by the banking system have increased substantially. Second, the US-subprime crisis turned into a worldwide financial crisis, suggesting that cross-border linkages are important as they may pose a serious threat to financial stability. Third, recent advances in empirical methods and data availability allow for a deeper investigation of this question.

In chapter 3, titled "Cross-border Exposures and Financial Contagion", I explore cross-border contagion using foreign claims from the BIS Consolidated Banking Statistics. I analyze cross-border contagion over the time period from 1999–2006 to check the evolution of contagion risk over time. I also attempt to identify the size of a systemically important shock for cross-border contagion. And finally, I study the economic impact of cross-border contagion besides identifying highly vulnerable banking systems.

In chapter 4, titled “Determinants of Financial System Fragility – A Regional Perspective” I analyze the determinants of regional banking system fragility while controlling for common economic shocks and explore the extent of banking system contagion within region and across regions. Therefore, this chapter contributes to the empirical literature on cross-border contagion by evaluating contagion across regions. A region is defined as a continent containing several banking systems. There are four different regions including 10 banking systems in Asia, 7 banking systems in Latin America, the US and Europe, each as one entity. I follow the methodology of Bae, Karolyi and Stulz (2003) to study regional banking system fragility through joint occurrences of negative extreme returns in banking system indices of multiple countries in a region. This chapter of my thesis analyzes whether regional banking system characteristics can explain regional banking system fragility (i.e. the number of banking systems having joint occurrences of extreme negative returns on a particular day) after controlling for common variables in a multinomial logistics settings. The contribution of this chapter in the existing literature includes: 1) an evaluation of banking system fragility through co-movements in banking stock indices that are measured on daily basis and provide a yardstick for instant evaluation of systemic crisis; 2) an assessment of the role of banking system liquidity, diversification of banking activities, banking competition, and the capitalization of the banking system for regional banking system fragility; 3) an investigation on whether specific banking system characteristics in the host region help in reducing the probability of cross-border contagion (by interacting them with the number of negative coexceedances in triggering regions); 4) an analysis on whether regional and country level banking characteristics play a role for an individual banking system to be in the tail with other countries in the region.

The last Chapter titled “An investigation of Inter-Industry Contagion: Banking and Financial Services Institutions” focuses on intra-industry contagion and inter-industry contagion within the financial sector in all regions. The intuition for studying inter-industry contagion follows Lang and Stulz (1992) who argue that firms using similar input to produce similar output are affected by same shock irrespective of their industrial classification (SIC codes). More specifically, all financial institutions including banks are competing for the financial liquidity and sell similar financial products with different brands. Therefore, inter-industry contagion may be as prevalent and important as intra-industry contagion and need similar treatment to limit their adverse

consequences. Inter-industry contagion has been assessed before when studying the significance of spillovers from life insurance to the banking system in an extant literature [see e.g. Brewer and Jackson (2002) for the US and Stringa and Monks (2007) for the UK]. This contribution is unique in terms of using a different set of financial institutions. It includes assets managers, consumer finance, specialty finance, investment services, mortgage finance, equity investment services and non-equity investment services. Moreover, it uses an explicit multinomial logistic framework to gauge the degree of intra-industry and inter-industry contagion through equity price co-movements while previous work relied on an event study methodology.

2 SHORT LITERATURE REVIEW ON FINANCIAL CONTAGION THROUGH CROSS-BORDER EXPOSURES

2.1 INTRODUCTION

A number of financial crises started as an idiosyncratic shock to local securities or local markets, but the dominos eventually spread to markets with no obvious economic linkage to the initial shock (e.g., the Mexican crisis in 1982 and 1994, the East Asian crisis in 1997, the Russian crisis in 1998, and the Brazilian crisis in 1999). Similarly, the financial turmoil that started in the summer of 2007 and intensified in 2008 as a local problem to the US-mortgage market has become a global concern for financial stability. These concerns are shared equally among policy makers in developed as well as in emerging market economies.

These financial crises have also attracted research interest in cross-border contagion and in empirical studies that investigate how a local turmoil may spill over to international markets with little or no economic linkages. Though there is no standard definition of cross-border contagion, we refer to it as a phenomenon where the financial crisis in one country increases the probability of crisis in other countries. We follow Calvo and Reinhart (1996) who distinguish between fundamentals-based contagion (which arises when the initial shock propagates through real linkages including trade relationships and international business cycles) and "pure" or "true" financial contagion (which arises in the absence of any potential economic interconnection among economies but mainly due to the herding behavior of international investors).

2.1.1 Fundamentals-based contagion

According to the fundamentals-based contagion, the high correlations in asset prices during crisis periods are dependent upon the state of macroeconomic interlinkages (e.g. Cole and Obstfeld, 1991; Backus et al., 1992; Baxter and Crucini, 1993; Cass and Pavlova, 2004; Pavlova and Rigobon, 2007). These papers use correlations in real economic variables like consumption, output, national savings, investment and exchange rate (terms of trade) and find some evidence of international transmission of local shocks. However, Kaminsky and Reinhart (2000) and van Rijckeghem and Weder (2001), among others, argue that these models have shortcomings in explaining cross-border contagion in regions with low economic integration like East Asia, Eastern Europe, and Latin America. Furthermore, these models also fail to explain the absence of cross-border contagion in other cases (such as the currency devaluations in Turkey and

Argentina in 2001) where the neighboring countries have significant real economic linkages. They argue that financial linkages may be more important, mainly due to the common bank lender effect. Peek and Rosengren (1997) support this argument by empirically investigating Japanese bank lending in the United States during the financial crisis in Japan in the early 1990s. They found that declines in the Nikkei index uncorrelated with movements in stock markets elsewhere may nonetheless be transmitted to other countries via the lending responses of Japanese banks.

2.1.2 Pure financial contagion

Pure financial contagion refers to domino effects among economies that are unrelated to economic fundamentals but mainly due to the investors' shifting appetite for risk. Moreover, information asymmetry among market players in financial markets may also lead to financial contagion as local traders replicating international portfolio composition may import a foreign idiosyncratic shock. The situation is more critical in emerging markets, where the process of generation, acquisition, and disclosure of information is not as standardized as in developed financial markets. The literature on cross-border financial contagion mainly exploits this heterogeneity in information and provides evidence that 'excess' price co-movement is a pervasive feature of many capital markets during uncertain times. See e.g. King and Wadhwani (1990); Fleming et al. (1998); Calvo (1999); Kyle and Xiong (2001); Kodres and Pritsker (2002); Yuan (2005) and Pasquariello (2007).

2.2 THEORETICAL FOUNDATIONS OF FINANCIAL CONTAGION

We restrict the review here to channels of interbank contagion. Bryant (1980) and Diamond and Dybvig (1983) are the founding fathers of the theory on individual bank runs. Bank runs are a potential equilibrium when banks invest in illiquid, long term assets. Later on, a number of papers have extended these theories to incorporate possible contagion effects. Allen and Gale (2000), for example, theoretically considered the possibility of financial contagion propagating through interbank exposures among banks in different regions. Their model exploits linkages between regions through correlation in liquidity needs of depositors and highlights the possibility of contagion when aggregate liquidity is not sufficient to absorb the idiosyncratic shock. Bhattacharya and Gale (1987) explain domino effects through banks' preference for long-term, high yielding, relatively illiquid assets, whereby banks typically liquidate their interbank claims

first in order to meet the unanticipated deposit outflows instead of liquidating their investments in long-term assets. Thus, the idiosyncratic financial problem in one bank or region may transmit through banking exposures in that region or other regions leading to financial contagion.

Allen and Gale (2000) also provide microeconomic foundations for interbank contagion by incorporating the structure of the interbank market. They emphasize that the scope of contagion not only depends on the size of interbank exposures relative to capital but also on the pattern of their linkages. Their major findings include that contagion is less likely for "complete market structure" (i.e., every bank has symmetric exposure to all other banks) than "incomplete market structure" (i.e., banks are exposed only to major neighboring institutions). Freixas et al. (2000) introduce a money centre structure in the model. The money centre is symmetrically linked to all the other banks, which are themselves not linked together. They show that, in some cases, the failure of a bank linked to the money center will not trigger the failure of the money center, but the failure of the money centre itself may trigger failures of the linked banks. Pritsker (2001) studies at least five separate channels through which real shocks are transmitted from one country to another, including the interbank channel. He finds that banks/financial institutions play a critical role in transmitting shocks because of their linkages to the real sector. Cifuentes et al. (2005) investigate the theoretical basis for contagious failures when a liquidity shock affects the banking system. They suggest that distress sales of illiquid assets depress their market value and that the regulatory requirement of "mark to market" further aggravates the situation of distressed institutions. Iori et al. (2006) use a theoretical model to discuss the insurance role of the interbank market and conclude that when banks are homogeneous in liquidity or size, the insurance role of interbank lending prevails and, in this situation, higher reserve requirements can lead to a higher incidence of bank failures. On the other hand, when banks are heterogeneous in average liquidity or average size, contagion effects may arise. Recently, Sachs (2010) provide an assessment of the impact of a the structure of interbank exposures on the stability of a stylized financial system.

2.3 EMPIRICAL STUDIES ON FINANCIAL CONTAGION

We can distinguish two different approaches to empirically investigate financial contagion. First, some papers have focused on the interbank market in transmitting financial shocks. Second, other papers have employed asset and equity prices to gauge the importance of contagion. We

first describe the results of the interbank papers and the different methods employed. Afterwards, we briefly touch upon the equity prices measures.

2.3.1 Interbank markets

Research papers have mainly focused on the role of the domestic banking system in transmitting financial shocks. Recently, however, some papers have started to explore the scope for cross-border contagion via interbank and other exposures of the banking system. We first discuss some papers on domestic interbank contagion and then we focus on cross-border contagion.

2.3.1.1 Domestic Interbank Contagion

There is a voluminous literature on domestic contagion studying various European interbank markets and the US interbank market. Degryse et al. (2009) provide a table with an overview on the empirical work on interbank market contagion. We reproduce that information with some updates in Table 2.1.

These studies use various measures of interbank exposure including interbank loans, payment and settlement obligations; OTC derivatives exposures and interbank credit lines. Most of the time they rely on supervisory reports or credit registers for such information. For example, Muller (2006) includes credit lines in the analysis and finds that they put an additional constraint on solvent banks' ability to pass excess liquidity over to banks, resulting in lack of liquidity during times of financial distress. Wells (2004) and Elsinger et al. (2006b) are distinct in terms of including off-balance sheet instruments in order to study interbank contagion. Liedorp, Medema, Koetter, Koning and Lelyveld (2010) test if interconnectedness in the interbank market is a channel through which banks affect each others' riskiness using quarterly bilateral exposures of all banks active in the Dutch interbank market between 1998 and 2008.

In these studies researchers mostly rely on counterfactual simulations to study the scope for contagion while using maximum available information. This artificially simulated data captures core characteristics of the actual phenomenon. The method of counterfactual simulation, though less accurate, provides the opportunity to concentrate on the relevant type of interbank exposure and the systemically important financial institution(s). Upper (2007) provide a detailed critical assessment of this methodology. Research studies based on counterfactual simulation include the seminal contribution by Sheldon and Maurer (1998), who estimate a matrix of interbank loans by

maximizing entropy using balance sheet data. Therefore, it simulates the propagation of an individual bank failure to the system through domino-type effects. Upper and Worms (2004) also apply a similar methodology to German banks' data, which is highly disaggregated both in terms of bilateral credit exposure and loan maturity.

In terms of findings, Upper and Worms (2004) conclude that the financial safety net (i.e., institutional guarantees for saving banks and cooperative banks) considerably reduces, but does not eliminate, the danger of contagion. Wells (2004), on the other hand, finds that a single bank failure has the potential to weaken substantially the capital holdings of the UK banking system. In the case of the Netherlands, Van Lelyveld and Liedorp (2006) find that the bankruptcy of one of the large banks will put a considerable burden on the other banks, but will not lead to a complete collapse of the interbank market.

Elsinger et al. (2006a) use the matrix of interbank credit relationships of Austrian banks in a more generalized risk management model. They explore the effects of macroeconomic shocks while simulating the impact of both credit risks and market risks on interbank payment flows and the value of bank capital. In this setting, the net value of banks is also affected by non-interbank activities (i.e. changes in monetary policy, exchange rate policy, and stock market or business cycle shocks). They find that correlation in banks' asset portfolios (as opposed to financial linkages) dominates contagion as the main source of systemic risk. Contagion is rare but can nonetheless wipe out a major part of the banking system.

Also, Degryse and Nguyen (2007) investigate the evolution and determinants of contagion risk for the Belgian banking system. They report that a move from a complete structure to a multiple-money-centre structure reduces the risk and impact of contagion, supporting the theoretical predictions in Freixas et al. (2000).

2.3.1.2 Cross-border contagion

Degryse and Nguyen (2007) do not only focus on domestic contagion, but they also investigate contagion stemming from interbank linkages of Belgian banks with foreign banks, and provide some estimate of cross-border contagion risk. Using the BIS data, Van Rijckeghem and Weder (2001 and 2003) find the common-bank-lending channel to be the pathway of contagion in the Mexican, Asian, and Russian crises. They also take one step forward in examining cross-border

exposures, and find that though cross-border exposures reduce local contagion risk, they increase the contagion risk stemming from foreign banks. Blavarg and Nimander (2002) also extend their analysis to include cross-border default on FX exposure. Cihak and Ong (2007) explore cross-border contagion at the bank level within Europe, whereas Derviz and Podpiera (2007) analyze cross-border contagion using the largest banks worldwide. Recently, de Haas and van Lelyveld (2010) use new panel data on the intra-group ownership structure and the balance sheets of 45 of the largest multinational bank holdings to analyze what determines the credit growth of their subsidiaries. A similar analysis by Cetorelli and Goldberg (2010) explore whether the consequences of shocks originating in home and host markets have likewise evolved. Global banks played a significant role in the transmission of the 2007 to 2009 crisis to emerging market economies. They examine the relationships between adverse liquidity shocks on main developed-country banking systems to emerging markets across Europe, Asia, and Latin America, isolating lending supply from lending demand shocks. Navaretti, Calzolari, Pozzolo and Levi (2010) examines whether multinational banks have a stabilizing or destabilizing role during times of financial distress using evidence from EU.

2.3.2 Equity prices

Other studies focus on equity prices to study financial contagion.[1] Among them, Bae et al. (2003) evaluate contagion in financial markets through coincidence of extreme return shocks across countries within a region and across regions. Building on the approach by Bae et al. (2003), Gropp and Moerman (2004) and Gropp et al. (2009), both examine cross-border contagion through equity price coexceedances of major European banks. They show that there may be tight links among banks within countries, as well as links connecting the major banking systems in Europe. They do not detect a major difference between the strength of links among euro area versus non-euro area countries. Also, Hartmann et al. (2005) assess cross-border contagion in the euro region and compare it with domestic contagion in US. They conclude that systemic risk though larger on both sides of the Atlantic during 1990s, is relatively higher in the US mainly due to 'mild' cross-border risks in Europe. Further, Bautista, Rous and Tarazi (2007) explore

[1] De Bandt and Hartmann (2001) provide a survey of various studies using asset price (equity) co-movements for measuring the impact of contagion.

determinants of domestic and cross-border contagion risk in Southeast Asia – the only study we are aware of that investigates bank contagion outside the US and Europe.

2.4 CONCLUDING REMARKS

This chapter has provided a short review of the literature on financial contagion, and in particular the role and impact of cross-border exposures. The issue of cross-border contagion has only recently been highlighted. This stems from different forces. First, in recent years, foreign claims held by the banking system have increased substantially. Second, the US-subprime crisis turned into a worldwide financial crisis, suggesting that cross-border linkages are important as they may pose a serious threat to financial stability. Third, recent advances in empirical methods and data availability allow for an investigation of this question.

Table 2.1: Literature on Interbank Contagion

Paper	Country /Region	Time Period	Interbank Exposure	Main Findings
Angelini,Maresca and Russo (1996)	Italy	21 business days in Jan 1992	End-of-day bilateral net balances for the 288 participants in the Italian netting system	4% of 288 participants has the potential of triggering sytemic banking crises
Amundsen and Arnt (2005)	Denmark	2004	Overnight loans between domestic counterparties with maturity less than 1 year	1-4% of Dannish Banking Assets
Blavarg and Nimander (2002)	Sweden	Sep 1999 - Sep 2001	Deposits, securities, and derivative; FX settlement exposures	16 of 108 cases with potential of contagion
Degryse and Nguyen (2007)	Belgium	Dec 1992 - Dec 2002	All on balance exposures	3 - 85% of total banking assets (depends on time and market structure)
Elsinger, Lehar and Summer (2006a)	Austria	Sep 2001	Loans to domestic banks	70% of all banks when LGD of 100%
Elsinger, Lehar and Summer (2006b)	United Kingdom	2003	Large exposures include off-balance sheet instruments Federal funds transactions	Probability of contagion default is close to zero
Furfine (2003)	United States	Feb 1998 - Mar 1998	Uncollateralized	Less than 3.5% of total assets
Lubloy (2005)	Hungary	50 days in 2003	All on-balance sheet exposures excluding equity	Limited
Mistrulli (2005)	Italy	Dec 1990 - Dec 2003	All exposures including credit lines	About 16% of total banking assets
Muller (2006)	Switzerland	Dec 2003	Loans to demestic banks	About 3% (20%) of total assets become insolvent (illiquid)
Sheldon and Maurer (1998)	Switzerland		Loans to domestic banks	Limited first round effects
Upper and Worms (2004)	Germany	Dec 1998	On-balance sheet exposures, foreign banks grouped by region	Up to 85% of total assets
Van Lelyveld and Liedorp (2006)	Netherlands	Dec 2002	Large exposures include off-balance sheet instruments	Up to 96% of total assets
Wells (2004)	United Kingdom	Dec 2000		Up to 25% of total assets

Source: updated version of Table 7.1 in Degryse, Kim and Ongena (2009) (see also Upper (2006))

3 CROSS-BORDER EXPOSURES AND FINANCIAL CONTAGION

Integrated financial markets provide opportunities for expansion and improved risk sharing, but also pose threats of contagion risk through cross-border exposures. This chapter examines cross-border contagion risk over the period 1999-2006. To that purpose we use aggregate cross-border exposures of seventeen countries as reported in the BIS Consolidated Banking Statistics. We find that a shock which affects the liabilities of one country may undermine the stability of the entire financial system. Particularly, a shock wiping out 25% (35%) of US (UK) cross-border liabilities against non-US (non-UK) banks could lead to bank contagion eroding at least 94% (45%) of the recipient countries' banking assets. We also find that since 2006 a shock to Eastern Europe, Turkey and Russia affects most countries. Our simulations also reveal that the "speed of propagation of contagion" has increased in recent years resulting in a higher number of directly exposed banking systems. Finally we find that contagion is more widespread in geographical proximities.

3.1 INTRODUCTION

The recent financial crisis, while having its roots in the US, spread globally in a very short span of time. The higher delinquencies in the mortgage market quickly ripple through, not only other financial markets in the US, but also abroad. As a result, the US subprime crisis turned into a global macroeconomic shock leading the US, along with the Euro zone and Japan, into recession. Though the governments and international financial institutions have announced bailout packages of trillions of dollars, the crisis is still unfolding. The deteriorating conditions, despite all coordinated interventions worldwide, expose fundamental weaknesses in the international financial system. The ongoing banking problems illustrate that monitoring financial stability is important locally as well as globally. Therefore, it is worth studying the transmission channels to be able to identify the vulnerabilities in the international banking system.

Banks are important because the instability of the banking sector in a country may have severe effects on other sectors of the economy. Moreover, the banking sector has a large penetration in the international market.[2] Therefore, a shock can be easily transmitted across borders due to an

[2] The reasons for international presence of banking system include: financial sector liberalization during the late 1990s has provided opportunities for international and cross-state (cross-border) banking. Second, the wave of mergers and acquisitions in the banking sector, both within and outside the United States, led to banking conglomerates at the international level that have greater financial needs and therefore establish banking

unsustainable loss on bank lending to foreign counterparties. In this chapter we study cross-border financial contagion, defined as the situation when an idiosyncratic shock that hits the foreign counterparty of a banking system results in non-payment of its foreign claims. If the banking system's aggregate equity is not enough to absorb this shock, the affected banking system will not fulfill its foreign obligations in the next round. This starts a domino effect that impacts other banking systems worldwide. Our focus is then on contagion due to non-repayment of cross-border credit exposures.

Foreign claims have increased both in absolute terms as well as relative to aggregate measures of real economic activity. The Bank for International Settlements (BIS) reported an increase in international claims on banks (in absolute terms), from $584 billion at end-1977 to $21 trillion in the second quarter of 2007.[3] Similarly, in relative terms, cross border exposures increased from 10% of world GDP in 1980 to 48% of world GDP in the second quarter of 2006.

Despite increasing foreign claims, only a few papers deal with this topic even though the ongoing credit crisis shows that cross-border contagion has become more important. The papers that deal with cross-border contagion can be subdivided in two groups, depending upon their approach. The first group employs equity prices to measure cross-border contagion (Hartmann, Straetmans and de Vries (2005), Gropp and Moerman (2005), Gropp, Duca and Vesala (2006) and Bautista, Rous and Tarazi (2007)).[4] These papers mostly study within country contagion or contagion within continents. The second group of papers uses data on bank exposures. In particular, they employ cross-border exposures, but focus on the effects on a single country (Van Lelyveld and Liedorp (2006) study interbank contagion for the Netherlands, while Degryse and Nguyen (2007) focus on Belgium), or they study contagion originating from the failure of emerging countries (McGuire and Tarashev (2007)).[5] These papers highlight the increasing

relationships across the world. Third, the integration of European countries into one monetary union also increased significantly the cross-border relationships. Fourth, banks have developed risk management systems allowing them to price and manage international assets more adequately.

[3] The increase may partially be attributed to a widening of the reporting area as data for the Cayman Islands, Hong Kong SAR, Singapore and other offshore financial centres are only available from end-1983. Whereas Australia, Bermuda, Greece, Guernsey, the Isle of Man and Portugal start reporting in or after 1998. However, banks located in these countries accounted for less than 5% of total claims of BIS reporting banks in 2006.

[4] De Bandt and Hartmann (2001) provide a survey of various studies using asset price (equity) co-movements for measuring the impact of contagion.

[5] Recently, a series of papers have studied banking contagion stemming from within country interbank exposures (see e.g. Angelini et al. (1996) and Mistrulli (2007) for Italy; Blavarg and Nimander (2002) for Sweden; Furfine

importance of cross-border exposures. We contribute to this literature by focusing on foreign claims of a sample of developed and developing countries to investigate empirically the potential for contagion risk through cross-border bank exposures across a more diverse set of countries and continents. We use the BIS Consolidated Banking Statistics for this purpose. We discuss several scenarios where we assume that an exogenous, sudden and idiosyncratic shock hits the foreign liabilities (entirely or partly) of a country. Following the initial failure, the shock propagates through cross-border exposures to banks in other countries and results into domino-type effects potentially causing systemic crisis. The contagion risk is gauged through the number of banking systems in other countries that potentially default following the non-payment of foreign claims against the failing country (ies).

This chapter therefore aims to contribute in several respects. First, it studies cross-border contagion for the first time using foreign claims from the BIS database. Second, while most papers focus on domestic interbank contagion at one point in time, our study provides an extension by looking at the evolution of cross-border contagion over the period 1999 and 2006. Third, we attempt to identify the size of a systemically important shock for cross-border contagion. Fourth, our analysis shows the economic impact of cross-border contagion besides indentifying highly vulnerable banking systems.

In this chapter we find that contagion risk and the speed of contagion through cross-border exposures have increased during 1999-2006. We find that a shock which affects partially the liabilities of one country may undermine the stability of the entire financial system. Particularly, a shock wiping out 25% (35%) of US (UK) cross-border liabilities against non-US (non-UK) banks could lead to bank contagion eroding at least 94% (45%) of the recipient countries' banking assets, assuming 100% loss given default (LGD). We also find that since 2006 a shock to Eastern Europe, Turkey and Russia affects most countries. Our simulations also reveal that contagion is often more confined to geographical proximities (i.e. regional, if not global), and that the US is the only country immune to cross-border shocks and contagion stemming from other countries.

(2003) for the US; Wells (2004) for the UK; Upper and Worms (2004) for Germany; Lubloy (2005) for Hungary; Elsinger, Lehar and Summer (2006) for Austria; and Muller (2006) for Switzerland).

The remaining of this chapter is organized as follows. Section 2 introduces the dataset while Section 3 elaborates on methodological details. The results are analyzed in Section 4. Section 5 concludes this chapter.

3.2 DATA

We use *bank credit* to foreign countries as the source of cross-border exposures. These foreign claims include the exposure of a country's banking system to all sectors (i.e. bank, non-bank and public) of other countries. BIS provides information on such foreign claims of reporting countries to the rest of the world in the *Consolidated Banking Statistics*.[6] It covers data on (national) contractual lending by the headquartered banks and all of their branches and subsidiaries worldwide to borrowers residing outside the country of origin (where the bank's headquarter is stationed) on a consolidated basis (i.e. net of inter-office account). It is one of the two broad categories in which BIS compiles data through the central banks of the reporting countries.[7] Further, we use foreign claims on immediate borrower basis, i.e. the allocation of foreign claims of reporting banks to the country of operations of the contractual counterparty. It means that, for example, we employ the foreign claims of *British* banks on *all* financial institutions operating in the US (irrespective of their nationality).

The reporting institutions in each country include all institutions that are allowed to *receive deposits and/or close substitutes for deposits and grant credits or invest in securities on their account*. Therefore, the reporting institutions include commercial banks, savings banks, savings and loan associations, credit unions or cooperatives, building societies, and post office savings banks or other government-controlled savings banks, but not central banks.

<please insert figure 3.1 here>

Our sample includes foreign claims outstanding at the end of each year for the banking systems of 14 European countries, Canada, Japan and US.[8] The foreign claims of these countries' banking systems are available for a long time period (1999-2006) allowing us to study contagion

[6] 'Reporting countries' include all participating countries in the BIS consolidated banking statistics. These countries report foreign claims vis-à-vis each other as well as against all non-participating countries. These non-participating countries are hereby called the non-reporting countries.

[7] BIS also reports *locational banking statistics*, i.e. international financial claims of all banks located in reporting countries to borrowers outside the geographical boundary on a gross (unconsolidated) basis.

[8] Included European countries are Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Netherlands, Portugal, Spain, Sweden, Switzerland, and United Kingdom.

risk over time. These foreign claims differ across countries, not only in absolute terms, but also in relation to the size of the banking system's aggregate equity. Figure 3.1 shows the ratio of foreign claims to a banking system's aggregate equity averaged over time for each country, both for the total foreign claims (sum over all countries) and the largest foreign claim (the country with the largest liability). The solid horizontal line at ratio=1 represents a situation where the foreign claims would be equal to a banking system's aggregate equity. If the ratio of a country is below the solid line, then the country has complete immunity against cross-border contagion. The reason is that the domestic banking system's aggregate equity is large enough to absorb a foreign shock due to non-payment of even all foreign claims. We find that the ratio of total foreign claims to bank aggregate equity is 0.4 in the US, which makes the US immune against to any cross-border contagion. While Italy and Japan have a low total foreign claims to bank capital ratio, it is still greater than 1, implying that these banking systems may default in later rounds of contagion. Other banking systems have a very high ratio so that even the largest foreign claim exceeds aggregate equity (i.e. a ratio larger than one). In some cases, these banking systems default already in the first round of contagion.

<please insert table 3.1 here>

Table 3.1 provides another set of summary statistics on foreign claims. We find that foreign claims are clustered in geographical regions. For example, Austria has 28 percent of its foreign claims on Germany; Belgium has 32 percent on France and Netherlands; Denmark has 41 percent on Germany and Sweden; Finland has 62 percent on Denmark and Sweden; Italy has 28 percent on France and Germany; Portugal has 36 percent on France and Spain; Sweden has 64 percent on Denmark, Finland and Germany; and Canada has 72 percent of foreign claims on the US only. The exceptions to the geographical proximities rule are the US and UK. Many countries (especially Japan and Switzerland) have high proportion of foreign claims on the US and UK irrespective of their location.

The dataset we use has several advantages. The consolidated banking statistics assigns foreign offices to their country of origin. This may be a better representation if foreign offices are affected more by an adverse shock in the country of origin as compared to a similar shock in the country of operations (in the latter case they could be rescued by the headquarters). Moreover, the consolidated banking statistics though are not the interbank data; it connects domestic

banking system to foreign economies thus providing a channel to gauge the impact of external shock. On the other side, the non-availability of interbank data is due to the fact that the BIS do not report the sectoral classification (i.e. bank, non-bank and public) of foreign claims of reporting countries vis-à-vis each counterparty.[9] Further, the consolidated banking statistics on immediate borrower basis does not take into account the nationality of contractual counterparties (i.e. for example, it reports foreign claims of British banks on all financial institutions in the US, but not on all American financial institutions). The BIS has managed this issue by reporting foreign claims on the ultimate risk basis, i.e. the allocation of claims of banks of reporting countries to the country of origin of the ultimate obligor. However, the data on ultimate risk basis are only available since March 2005, preventing us from evaluating contagion risk over time.

Data on bank equity for the financial institutions of each reporting country are taken from *Bankscope*. We sum up ordinary equity of all financial institutions except the Central banks to get the aggregate bank equity at country level for each year. We preferably use consolidated accounting statements of all reporting financial institutions in Bankscope in these calculations. If the consolidated statement is not available, then we use the unconsolidated/aggregate accounting statement, whatever is available. Similarly, if accounting statements are available on both IFRS and Local GAAP reporting conventions, then we use the former convention.

3.3 METHODOLOGY

We use the methodology of Upper and Worms (2004) for our contagion exercises. This methodology simulates a mechanical chain of domino effects caused by an exogenous initial shock. Our exogenous shock is the default of a triggering country (i.e. its bank, non-bank and public sector) on its foreign liabilities. As a result, the banking system of the recipient country suffers from non-payment of its foreign claims on the triggering country. The banking system of the recipient country defaults in the first round when its foreign claims against the bank, non-bank and public sector of the triggering country exceed its aggregate bank equity. The failing recipient countries in each round may affect other countries in successive rounds due to their combined effects. The contagion process stops when there is no new country that defaults in that round (i.e. combined foreign liabilities of both the trigger and failed recipients of previous

[9] BIS reports sectoral classification at aggregate level only. For example, it reports foreign claims of British banks on banks of the rest of the world, but not foreign claims of British banks on banks in the US.

rounds are less than the bank equity of each non-failed recipient country). We employ this methodology over our entire sample period 1999-2006 to evaluate the impact of contagion over time.

We can represent the countries' foreign claims and liabilities as follows:

$$X = \begin{bmatrix} \overbrace{x_{1,1} \cdots x_{1,j} \cdots x_{1,N}}^{\text{Re porting Countries}} & \overbrace{x_{1,N+1} \cdots x_{1,N+M}}^{\text{Non-Re porting Countries}} \\ \vdots \ddots \vdots \quad \vdots & \vdots \quad \ddots \quad \vdots \\ x_{i,1} \cdots x_{i,j} \cdots x_{i,N} & x_{i,N+1} \cdots x_{i,N+M} \\ \vdots \ddots \vdots \quad \vdots & \vdots \quad \ddots \quad \vdots \\ x_{N,1} \cdots x_{N,j} \cdots x_{N,N} & x_{N,N+1} \cdots x_{N,N+M} \end{bmatrix} \text{ with } \sum_{j=1}^{N+M} x_{ij} = a_i \text{ and } \sum_{i=1}^{N} x_{ij} = l_j$$

where x_{ij} are the consolidated foreign claims of the banking system of country i on the bank, non-bank and public sector of country j, N is the number of reporting countries (N=17 in our case) and M is the number of non-reporting countries. The summation $\sum_{j=1}^{N+M} x_{ij} = a_i$ represents the total foreign claims of country i on the rest of the world. Similarly, $\sum_{i=1}^{N} x_{ij} = l_j$ represents the total foreign liabilities of country j towards the rest of the reporting countries. This matrix also shows the foreign claims on the M non-reporting countries.

The aggregate bank equity has an initial value C_i equal to the ordinary equity directly observed from the balance sheets of financial institutions in country i. It is reduced by the amount of the foreign claims of country i against the triggering country in the first round, and then by the cumulative amount of the foreign claims of country i against all failing recipient countries in each round of contagion. Therefore, the country i defaults when:

$$C_i - \sum_{j=1}^{N+M} \lambda_j \theta x_{ij} < 0$$

where C_i represents aggregate bank equity of country i, λ_j is a dummy variable whose value is 1 if the country j defaults, and 0 otherwise, θ shows the percentage of loss given default

(LGD), whereas x_{ij} is obtained from the previous matrix representing the consolidated foreign claims of country i on country j .

<please insert figure 3.2 here>

Figure 3.2 depicts the same procedure in a graphical manner. The domino effect starts when the triggering country defaults on its foreign liabilities. Depending upon our assumptions on LGD, the loss on foreign claims to the triggering country is fully or partially ascertained by recipient countries. If aggregate bank equity of a recipient country is larger than the shock, the banking system survives with partial damage to the aggregate equity. On the other hand, if the aggregate bank equity of the recipient country is not sufficiently high to absorb the shock, the banking system defaults. Here we assume that the banking system's default would lead to the default of all sectors of the country through domestic spillovers; therefore the foreign claims on this country add to the shock for the next round of contagion.[10] In each successive round, all non-defaulting countries have lower chances of survival due to combined losses on foreign claims to defaulting countries in the preceding round. The system becomes stable when no country defaults in the current round or all countries default.

There are some caveats to this simulation process. Although aggregate foreign claims at the country level are directly observable, the distribution of foreign claims among financial institutions within each country is not known. This implies that we need to make some assumptions on the distribution of foreign claims. As a first step, we assume that *all* banks share foreign claims on other countries proportional to their assets. Furthermore, we assume that *all* banks' equity is employed as a cushion to absorb the shock. Therefore the failure of a triggering country on its foreign liabilities affects all banks together. In later exercises; however, we assume that foreign claims are distributed among *large* banks only.

Further we assume an exogenously determined LGD that is kept constant over time, and during all rounds of contagion and across all countries. While this may seem a very strong assumption,

[10] Unfortunately we do not have data on a country's *banking system* exposure to another country's *banking system*. We only have data on the claims of a country's *banking system* against *all other sectors* (i.e., bank, non-bank and public) of each of the other countries. So, unless we assume that the banking system's default would lead to the default of bank, non-bank and public sectors, we cannot see the contagion in later rounds. To the best of our knowledge, there is still no available cross-country dataset that would allow doing the simulations with actual interbank cross-border exposures.

we find however that all included countries have a similar and stable sovereign credit rating throughout the sample period. Therefore we deduce that all countries may have similar standing to deal with a crisis and hence a similar LGD for their respective debtors. In relation to the percentage of the LGD, we analyze several scenarios, given that there is no consensus in existing estimations about the recovery rates.[11] Lastly it is also assumed that no netting of exposures occurs in the event of default.[12]

3.4 RESULTS

We analyze the impact of a country's default on its foreign liabilities. The non-payment of the foreign claims of the banking systems of recipient countries vis-à-vis this triggering country erodes the bank capital of the recipient countries. The magnitude of the final shock is the LGD times the initial shock. In our examination we use various levels of LGD (i.e. 20%, 40%, 60%, 80%, and 100%); however, we find a significant decline in contagion when LGD is below 60%. Therefore we report simulation results for 100% LGD (worst case) and 60% LGD (intermediate case) only. We present simulation results for two different cases: 1) *all* banks are internationally exposed; 2) only *large* banks are internationally exposed. In each case, we evaluate the possible contagion stemming from exposures to reporting and non-reporting countries, identify the most vulnerable banking systems, examine contagion risk over time, and report the economic significance of potential contagion.

3.4.1 Case 1: All banks are internationally exposed

In case 1, we investigate cross-border contagion of a default of the triggering country on all its foreign liabilities, under the assumption that foreign claims towards a recipient country are distributed among all banks in that country. Cross-border contagion occurs when the banking system in at least one of the recipient countries is not able to absorb the shock triggered by the non-payment of its foreign claims at the given LGD (i.e. the banking system's aggregate equity

[11] For example, James (1991) estimates losses for US bank failures for the period 1985-1988, and finds that the loss is on average 30 percent of the failed bank's assets. For the UK, a bank study of recoveries by the UK Deposit Protection Fund in the early 1990s reports a median loss-given-default of 35% for failed UK banks (see Jackson 1996). However the sample contains only 14 banks, which are small and the LGD has a large variance, from 0% to 100%. One important issue to keep in mind is that these are ex-post loss rates. It is possible that expected losses at the moment of the shock are higher and therefore banks may not be able to continue to operate if all its capital is *perceived* to be at risk.

[12] It is important to assess contagion risk under different netting assumptions, given that it is possible that some netting would occur. However we are prevented from doing this exercise, given that our data does not allow us to calculate a country's banking system net exposures to another country' banking system.

is less than the foreign claims on the triggering country). In this exercise, the national banking system acts as one unit, i.e. all banks hypothetically pool their equity to compensate the losses incurred on foreign claims to defaulting countries. We have 17 reporting countries that may be a trigger. We label these as *reporting triggers.* We also have the claims of the banking systems of the different reporting countries on 20 non-reporting countries, which we label as *non-reporting triggers*. These non-reporting countries include countries from Eastern Europe (plus Russia and Turkey), Latin America and Asia.

<please insert figure 3.3 here>

Figure 3.3 displays the results of our simulation exercise. It shows that contagion risk has increased over time particularly in terms of an increasing number of triggering countries that may lead to contagion, as well as more failing recipient countries to each trigger. The upper panels show the results for reporting triggers while lower panels elucidate contagion from non-reporting triggers. Each scenario is evaluated at 100% LGD and 60% LGD. Panel (a) shows that the number of reporting triggers increased to eight in 2006 (i.e. the US, UK, Germany, Italy, Netherlands, Denmark, Sweden and Finland), as compared to only four countries in 1999 (i.e. the US, UK, Germany and the Netherlands). The US, UK and Germany would have triggered cross-border contagion over the entire sample period. The contagion triggered by the US is the most severe, and spreads to almost all reporting countries in many years. The default of UK also affects a majority of other reporting countries (12 to 15 countries). The US and UK have triggering potential even at low percentages of LGD. The impact of cross-border contagion from Germany has particularly increased over time, affecting 13 countries in 2006. The Netherlands almost always affects Belgium, while default of any Scandinavian country affects the whole neighboring region. Japan triggers cross-border contagion in 2002 only affecting Ireland. Similarly Italy triggers cross-border contagion in 2006 only; however it would affect 14 out of 16 recipient countries. Panel (b) depicts a similar pattern for 60% LGD: cross-border contagion is triggered by the US, UK, Germany, and Scandinavian countries.

<please insert figure 3.4 here>

Similarly, panel (a) of figure 3.4 reports contagion triggered by non-reporting countries/regions at 100% LGD. Norway causes cross-border contagion to neighboring countries in the

Scandinavian region. Moreover, the default of Latin American countries has cross-border implications for Spain throughout. Distinctively, the default of Eastern Europe (plus Russia and Turkey) affects 15 recipient countries. Though Austria is the only country that is directly exposed to the shock, the combined effect in later rounds cause Scandinavian countries to default and then the contagion spread to Ireland and other major European countries in later rounds. Panel (b) of figure 3.4, that reports results for 60% LGD, shows a low contagion potential from non-reporting countries.

<please insert table 3.2 and table 3.3 here>

Another interesting question is which banking systems are more vulnerable to contagion, and thus often appear as failing recipient countries. We find that the number of directly exposed banking systems (that default in first round) reaches its highest level in 2006, when 12 banking systems default immediately after the triggering countries experience the shock. Table 3.2 and 3.3 provide the direct and total cross-border contagion risk in 2006, respectively. The rows indicate the triggering countries that initiate contagion whereas the columns represent the recipient countries. Sweden and Ireland are the most directly exposed banking systems that default 5 times and 4 times respectively (see table 3.2). On the other hand, Italy and the US are completely immune to cross-border shocks taking into account 'all-round' contagion effects as shown in table 3.3.

Our results show that the US banking system is always resilient to cross-border contagion risk. Also, in recent years, the Italian banking system has become resilient to contagion risk from any of the triggering countries. This may stem from the large number of small banks in Italy that are not exposed heavily. Therefore the result here may be driven by our strong assumption that all banks, including small banks, are internationally exposed. We relax this assumption in the next exercise. Other recipient countries including Austria, Denmark and Finland are not completely resilient to contagion risk but default occasionally only in the last rounds. Therefore, we classify them as less vulnerable recipient countries. Lastly, Japan, France and Portugal have moderate level of contagion risk as they default in intermediate rounds.

<please insert figure 3.5 here>

We also find that the number of banking systems that default in the first two rounds has increased for each triggering country in recent years. The increase is more profound when the triggers are the US and UK as shown in figure 3.5. Specially, the US affects 13 or more countries in just two rounds (see figure 3.5, panel (a)). Similarly, the default of UK leads to a cross-border contagion affecting 9 or more countries in first two rounds throughout the sample period as shown in panel (b) of figure 3.5.

<please insert figure 3.6 here>

The economic impact of possible contagion is shown in figure 3.6. We measure the economic impact of contagion as the percentage of total assets of the defaulting banking system(s) compared to total assets of all banking systems that could potentially be affected (excluding the triggering country). We find that the failure of the US has the largest economic impact throughout the time period. Its failure would potentially affect more than 90 percent of the global banking assets. Next to the US, the impact of the failure of UK is the most severe as it would affect around 50 percent of the banking assets in many years. The impact of Germany's failure is increasing over time and would potentially affect around 50 percent of banking assets in 2006 (similar to the UK). Other countries' cross-border exposures generate a much lower impact.

3.4.2 Case 2: Only large banks are internationally exposed

In case 2, we assume the same initial shock as in case 1; however, foreign claims are assumed to be distributed among large banks only. We are therefore considering that the international banking market presents a two tier structure, where only large banks operate across borders in the interbank market and act as money centers for smaller domestic banks. Evidence consistent with this structure is found for example by Gropp, Duca & Vesala (2006), who show that small banks neither cause nor suffer from cross-border contagion, even though all banks are equally likely to experience domestic contagion. We define large banks as banks with at least $127 billion in assets, this is the maximum possible bank asset size such that we include at least one bank from each country (this cut-off is close to the $170 billion cut-off used in Gropp, Duca and Vesala (2006)). There are 193 banks of the total 6392 banks that report to Bankscope, that have $127 billion or more total assets. Moreover, we assume that the selected large banks in each country act as one unit and hypothetically pool their equity to safeguard against contagion risk. Here we investigate whether the aggregate bank equity of the large banks is sufficient to absorb

the shock. In this case, our assumption about domestic spillovers is more stringent (i.e., the failure of large banks leads to the default of all sectors of the recipient country). In general, we expect more contagion to take place compared to case 1, as we only include banks' equity of large banks as a cushion for default on foreign claims.

For brevity, we only discuss the main findings and differences compared to case 1. We find more intense contagion as expected. At 100 percent LGD, all countries except Switzerland and Canada, trigger in at least one year contagion that affects at least 15 countries. More specifically, France, Germany, Italy, Japan, Netherlands, UK and the US trigger contagion throughout the sample period, while other countries trigger contagion only occasionally. The US again turns out to be a trigger that affects all other countries, while other countries affect all but the US.

We find that the Italian banking system that is immune to any cross-border shock in case 1, not only triggers contagion but is also affected by other triggers. The default of the Italian banking system has severe implications for neighboring European countries including Portugal, Austria and Germany. Once any of these European countries defaults, then a chain of bank failures starts that ultimately leads to the default of all banking systems except the US. However, the speed of contagion is low, as it takes several rounds to complete the contagion process.

With 60 percent LGD, we find that the US affects all countries during each year in the sample period. The UK, Italy, Japan, Netherlands, France Germany and Spain also trigger significant contagion even at 60 percent LGD. Other countries are gaining contagion momentum in recent years, especially after 2002. Scandinavian countries trigger contagion, but only on a limited scale at the regional level.

Regarding the effects of the non-reporting countries with 100% LGD, Eastern Europe (plus Russia and Turkey) and Latin America affect almost all countries throughout our sample period, whereas Norway's contagion impact is limited to the Scandinavian region except for 2003-2005. Asia and off-shore centers cause contagion mainly during 1999-2002. With an LGD of 60%, Eastern Europe, Latin America and off-shore centers cause global contagion whereas Norway causes regional contagion.

<please insert table 3.4 and table 3.5 here>

In terms of direct exposure (recipient countries which fail in the first-round), we find a similar pattern as the one we observe in case 1. Table 3.4 reports direct cross-border contagion in 2006 and reveals that the banking systems that are often directly exposed are Portugal (13 times), Ireland (6 times), Netherlands (5 times), Sweden (5 times) and Switzerland (5 times). The recurrence of Portugal is expected because of the low representation of large banks. We find that Italy and the US are not directly exposed to any triggering countries. On the other side, UK and the US affect most countries in the first round. Finally, table 3.5 shows that the total contagion effect. US affects all other countries and France, Germany, Italy, Netherlands, Spain and UK affect all countries but the US. Again we observe Scandinavian countries affect other countries in their region.

It is important to note that the US remains completely resilient to contagion risk in case 2 as well. Moreover, Italy as well as Austria, Finland and Portugal may be classified as less vulnerable countries.

3.4.3 Systemically important country shock/bank

The recent subprime crisis also raises questions whether a single large bank or a group of banks can trigger a chain of dominos that potentially leads to cross-border contagion. We investigate this possibility by considering a shock to a fraction of a country's cross-border exposure only. We simulate initial shocks ranging from 5 percent to 100 percent, in steps of 5 percent each. This allows us to check the critical magnitude of the initial shock that would potentially cause a significant loss of banking assets of recipient countries through cross-border contagion, and compare it with the concentration of the triggering countries banking system. There is no clear definition of a systemically important bank/shock. For our analysis, we consider a systemically important bank/shock to be one affecting 20 percent of other banking systems assets.

<please insert figure 3.7 here>

Figure 3.7 panels, (a), (b), and (c), display the results for our three most important triggers, US, UK and Germany, respectively. Figure 3.7 panel (a) shows that, in 2006, an initial shock of as low as 25 percent of the US's foreign exposure would have triggered cross-border contagion, eroding 95 percent of the banking assets at 100% LGD, of which 80 percent of banking assets are lost in the first round. Whereas the same initial shock would erode only 3 percent of banking

assets at 60% LGD. However, an increased initial shock of 60 percent shock could lead to a massive erosion of 72 percent of the banking assets.

A similar analysis for the UK is reported in panel (b) of figure 3.7, again assuming a LGD of 100%. It reveals that an initial shock of 35 percent of its cross-border exposures lead to an erosion of 45 percent of the banking assets of all recipient countries. Compared to this 35 percent shock, a 100 percent default of UK would lead to the erosion of 49 percent of the banking assets, of which 33 percent would happen in the first round. On the other hand, assuming 60 percent LGD, a 75 percent initial shock would have resulted in cross-border contagion eroding 45 percent of the banking system. Lastly, panel (c) reports the results for Germany: an initial shock wiping out 60 percent of Germany's cross-border liabilities affects 50 percent of the banking assets assuming 100 percent LGD. However, Germany would not trigger any significant contagion assuming 60 percent LGD during our sample period.[13]

In sum, based on an LGD of 100% and for 2006, we find that a 25%, 35%, and 60% shock to respectively the US, UK and Germany, can be classified as a systemically important shock. This compares to three-bank concentration ratios of 20%, 44% and 25% for the US, UK and Germany, respectively. This shows that a shock that would affect the liabilities of the three largest banks (and an equal fraction of the non-bank and public sector) in the US and the UK has the potential to lead to a systemically important shock. In unreported exercises, we also find that over time a smaller shock might become a systemically important one. For example, the size of a systemically important bank/shock dropped for the US from 45% in 1999 to 25% in 2006, and for the UK from 50% to 35%.

3.4.4 Is contagion a result of high exposures or limited capital?

Our results show that contagion risk exhibits considerable heterogeneity among countries as well as important time variation. We now investigate how sensitive contagion risk is to high cross-border exposures and to insufficient bank capital during our sample period. We do this by employing a probit model where the dependent variable is a binary number that equals one whenever a country is a failing recipient after a triggering country fails, and zero otherwise. The independent variables employed in the regression include the ratio of capital to total assets of the

[13] We have also checked the systemically important shock for the US, UK and Germany during initial years of the sample period. Our findings are similar to what we have found in 2006 as reported above.

recipient, the ratio of foreign claims to total assets of the recipient and the ratio of foreign claims against the triggering country. We also control for year fixed effects in a separate model.

<please insert table 3.6 and table 3.7 here>

We report the summary statistics of the capital to asset ratio and the foreign claims to asset ratio in table 3.6. We find that financial institutions in Finland, the US, Belgium and Switzerland, on average, have 10 percent or more equity capital relative to their total assets. Whereas Canada, Japan and Germany are on the lower side of the equity capital ratio, financial institutions around the globe have a capital ratio of 8 percent on average. With respect to the foreign claims to assets ratio, we find that Japanese institutions are not highly exposed (only 6 percent foreign claims relative to total assets), while European institutions have around 40 percent foreign claims relative to total assets. The standard deviation of the entire sample is 4% for the capital to asset ratio and 16% for the foreign claims to asset ratio. Table 3.7 reports that the variables in the probit model (1) explain 38 percent of the variation in the probability of being a recipient country. With the addition of year fixed effects, the fit improves to 39 percent. The likelihood ratio test rejects the null hypothesis that the joint effect of all independent variables is equal to zero. We find that both the foreign claims to total assets ratio and ratio of foreign claims to trigger are statistically significant at 1 percent, whereas the capital to asset ratio is significant at 5 percent. The marginal effects show that a one standard deviation increase in capital to asset ratio decreases the probability of the default of recipient country by 2.2 percentage points. Similarly, one standard deviation increase in foreign claims to total assets ratio increases the probability of the default of a recipient country by 4.5 percentage points. Moreover, all signs are robust to year fixed effects whereas marginal effects slightly decline.

3.5 ROBUSTNESS

<please insert figure 3.8 here>

We investigate the robustness of our results to a set of extensions. The contagion potential is evaluated with different loss given default on short and long term liabilities. We also use an alternative classification of foreign claims, ultimate risk basis, for robustness check. Finally, we consider the European Union and the Euro area to be one banking system. This allows us to

study contagion interaction with the other countries we consider (i.e. Canada, Japan, Switzerland and the US).

In case 1 and case 2 we assumed that the idiosyncratic shock affects all exposures equally whether short-term or long-term. We understand that this may be a strong assumption, given that it is likely that recovery rates will be higher for long-term exposures. Therefore we next assume that countries default only on their short-term liabilities (i.e., we assume 100 percent LGD for the short-term foreign claims and 0 percent LGD for the long-term). This exercise can be seen as a scenario in which a country faces a shortage of liquidity and therefore the shock is mainly due to a refinancing problem.

We refer to short-term liabilities as foreign claims of less than one-year maturity. This presents an extreme scenario when short-term claims have no collateral whereas long-term loans are completely secured. The results are shown in Figure 3.8. Panel (a) reveals that the UK is the most important triggering country while the US now has very low triggering potential. For example, Figure 3.8 panel (a) shows that UK can affect 9 recipient countries while the US affects only one country in 2006. The main reason could be the dominance of European countries in our sample. Since London is the financial hub for international banking, UK owes relative more short-term claims than long-term claims. Further, Switzerland and Ireland emerge as the most directly exposed countries in our sample period. Particularly, in 2006, UK directly affects Ireland and Switzerland while the US affects Switzerland only as shown in table 3.8. However, in later rounds, UK affects 7 more countries as shown in table 3.9.

<please insert table 3.8 and table 3.9 here>

Second, our analysis up to now employed foreign claims on immediate borrower basis (i.e. allocation of foreign claims to the country of operations of the contractual counterparty). The BIS has started compiling data of foreign claims on ultimate risk basis (i.e. allocation of foreign claims to the nationality of the contractual counterparty) in March 2005, but only for eleven countries in our sample. These countries are Belgium, Canada, France, Germany, Italy, Japan, Netherlands, Portugal, Switzerland, UK and the US. We replicate case 1, where we assumed that all banks are internationally exposed, but now with foreign claims on ultimate risk basis for December 2006 for these 11 countries only.

Assuming 100 percent LGD, we find contagion results similar to case 1. The US again is the most devastating triggering country and may lead to contagion that affects all other reporting countries except Italy. Similarly, the default of UK poses contagion threat to 7 other countries, Germany is important for 3 other countries, and the Netherlands only affects Belgium. The speed of contagion increases in this exercise as all triggering contagion takes at most two rounds.

The economic impact is also similar to our findings as discussed for case 1: an exogenous default to the US may affect 94 percent of total assets of other banking systems. Similarly, the contagion triggered by the UK, Germany and Netherlands affect 40.9 percent, 12.8 percent and 3.6 percent of total assets of other banking systems respectively. Finally, we observe that the pattern of direct exposure is also exactly the same in both cases (i.e. comparing directly exposed contagion from ultimate risk basis with immediate borrower basis of the corresponding reporting countries).

The results on direct exposure are also robust: the US causes five recipient countries to fail immediately due to cross-border contagion. Similarly, the UK affects three recipient countries, while the Netherlands and Germany affect one recipient country each. Further, using cross-border claims on ultimate risk basis we find the Netherlands to be the most vulnerable recipient country for cross-border contagion. This is in line with earlier findings using cross-border claims on immediate borrower basis.

Next, we consider the European Union (EU) or the Euro Area as one banking system, and include also Canada, Japan, Switzerland and the US. We assume 100% LGD and all banks to be internationally exposed. We find that the US is still immune to contagion. Moreover, the US has an impact on Europe, and on all other countries. This contagion pattern is consistent throughout all the sample period. These results reflect the fact that the US is less exposed to Europe than Europe is to the US. The ratio of US claims against the EU over its domestic banking assets is 3.7%, less than half the ratio of EU claims against the US over EU's banking assets (which average 8.5% over our sample period). Therefore transatlantic contagion is still important for Europe as a whole. Moreover, the financial integration process that Europe has experienced in the last decades should lead to larger cross-border exposures among all member countries, leading to higher within Europe contagion potential. This process actually increases the

probability that a US shock that may initially affect only a few countries will end up affecting most of the member countries.

Finally, we also wanted to check the possibility for contagion with risk-weighted capital instead to total ordinary equity capital as reported in balance sheets on financial institutions. However, we find that financial institutions in many countries do not report risk-weighted capital in a consistent manner. Therefore, the results would be highly biased towards the countries reporting the risk-weighted capital only.

3.6 CONCLUDING REMARKS

The risk of contagion through the banking system is not limited to domestic boundaries. In recent years, foreign claims held by the banking system have increased substantially suggesting that cross-border contagion needs further consideration as it may pose serious threats to financial stability. We find for 2006 that a shock wiping out 25% (35%) of US (UK) cross-border liabilities against non-US (non-UK) banks could lead to bank contagion eroding at least 94% (45%) of the recipient countries' banking assets. We also find that since 2006 a shock to Eastern Europe, Turkey and Russia affects most countries. Moreover, our simulations reveal that contagion risk and the "speed of propagation of contagion" have increased over time during the period 1999 to 2006. Finally, we find that contagion is more widespread in geographical proximities.

Figure 3.1: The Ratio of Foreign Claims to Bank Aggregate Equity

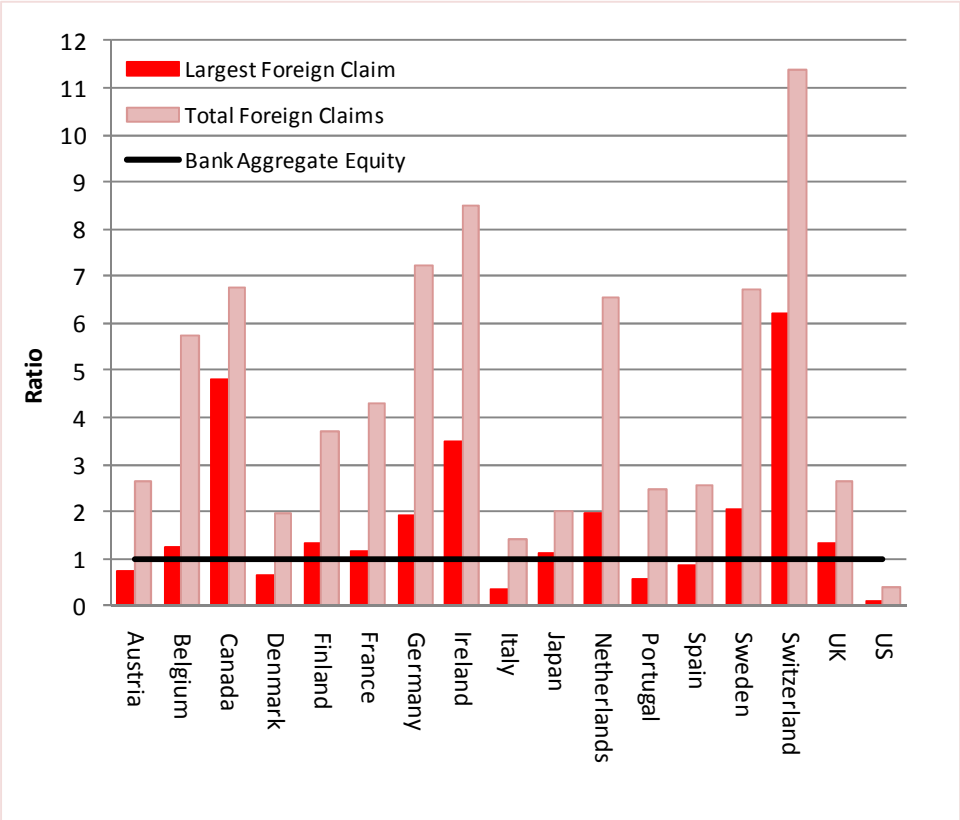


Figure 3.1 shows the ratio of foreign claims to bank aggregate equity averaged over time for each country. A solid horizontal line at ratio=1 represents a situation when foreign claims is equal to bank aggregate equity.

Figure 3.2: The Contagion Process

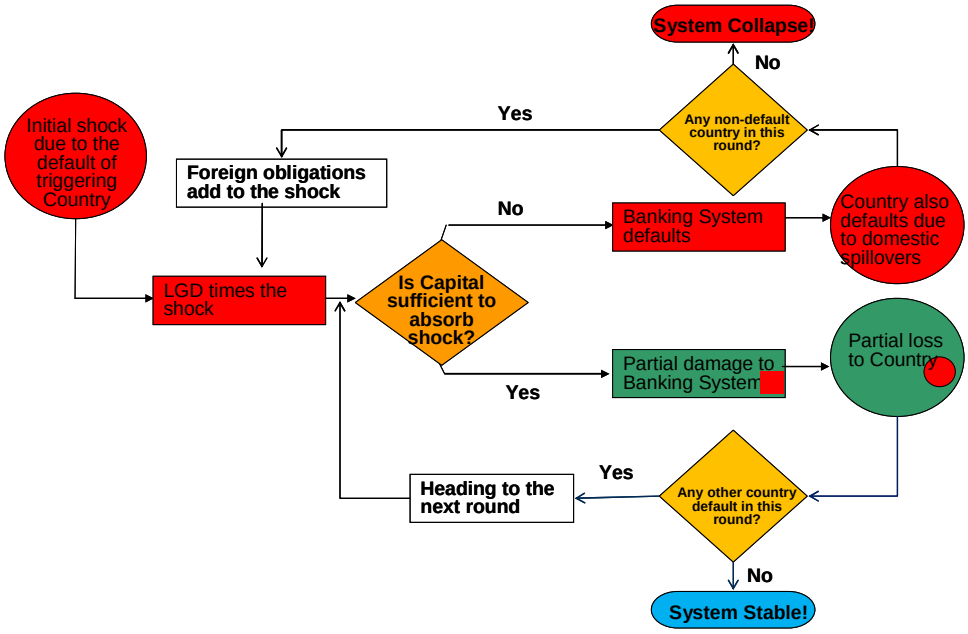


Figure 3.2 shows the contagion process. The red circle on the left represents an initial shock triggered by the default of a reporting country. The shock is then multiplied by the Loss Given Default (LGD) to determine the effective burden on recipient countries; if that burden is less than the aggregate bank capital then the country survives to the next round though it loses bank capital partially. Such country is represented by a green circle and the partially lost capital is represented by the red circle inside. On the other hand, if the burden is greater than aggregate bank capital then the recipient country would also default as represented by the red circle on the right. Contagion would continue to the next round if there is at least one additional country defaulting in the current round.

Figure 3.3: Contagion Triggered by Reporting Countries - All Banks are Internationally Exposed

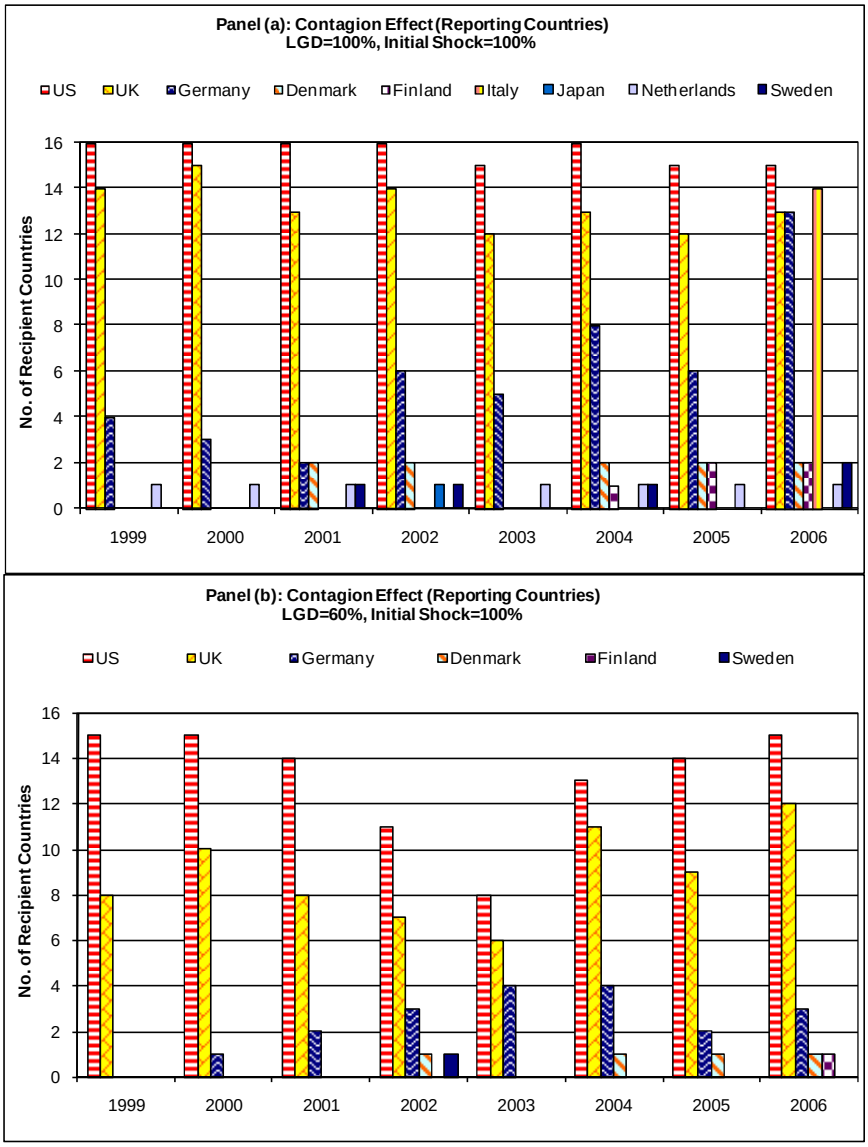


Figure 3.3 illustrates the number of countries (on y-axis) that default due to cross-border contagion from reporting countries. Each column represents a triggering country during 1999-2006. Panel (a) is based on 100 percent Loss Given Default (LGD) whereas panel (b) is based on 60 percent LGD.

Figure 3.4: Contagion Triggered by Non-Reporting Countries - All Banks are Internationally Exposed

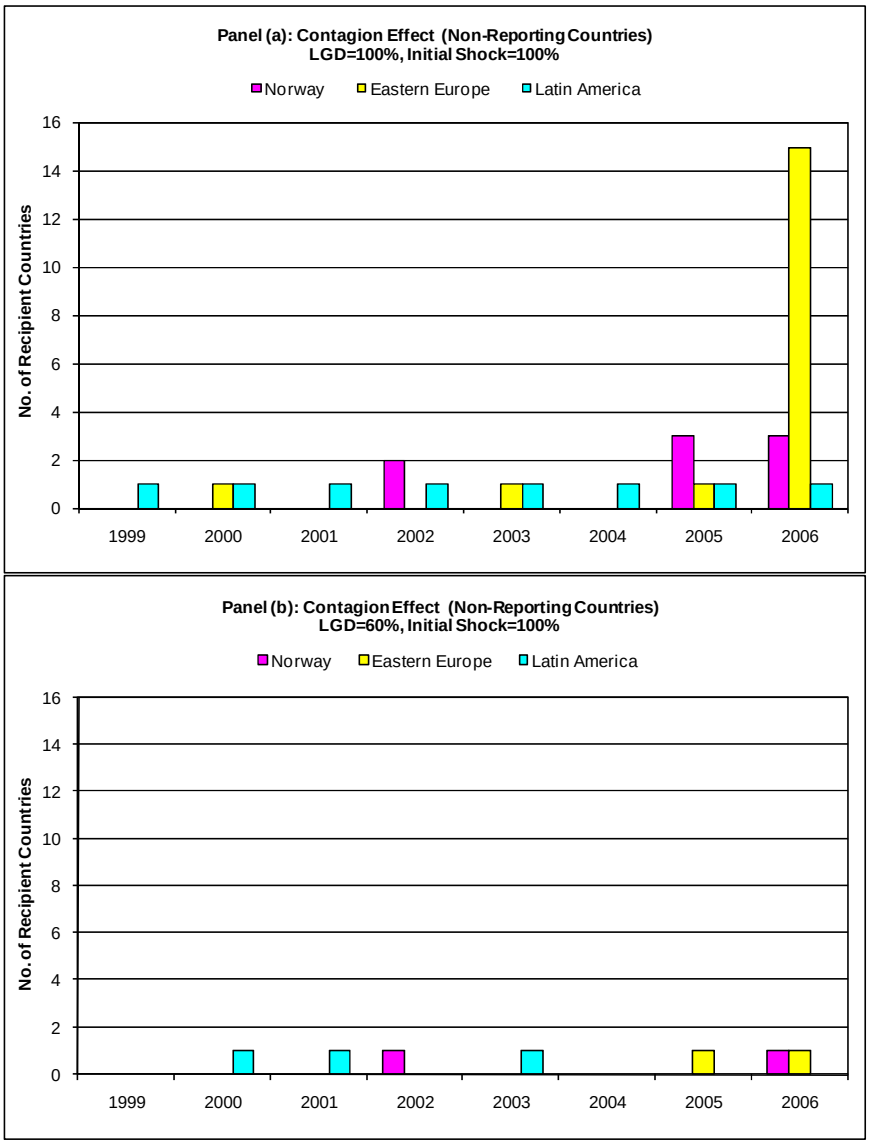


Figure 3.4 illustrates the number of countries (on y-axis) that default due to cross-border contagion from non-reporting countries. Each column represents a trigger during 1999-2006. Panel (a) is based on 100 percent Loss Given Default (LGD) whereas panel (b) is based on 60 percent LGD.

Figure 3.5: Speed of Contagion – All Banks are Internationally Exposed

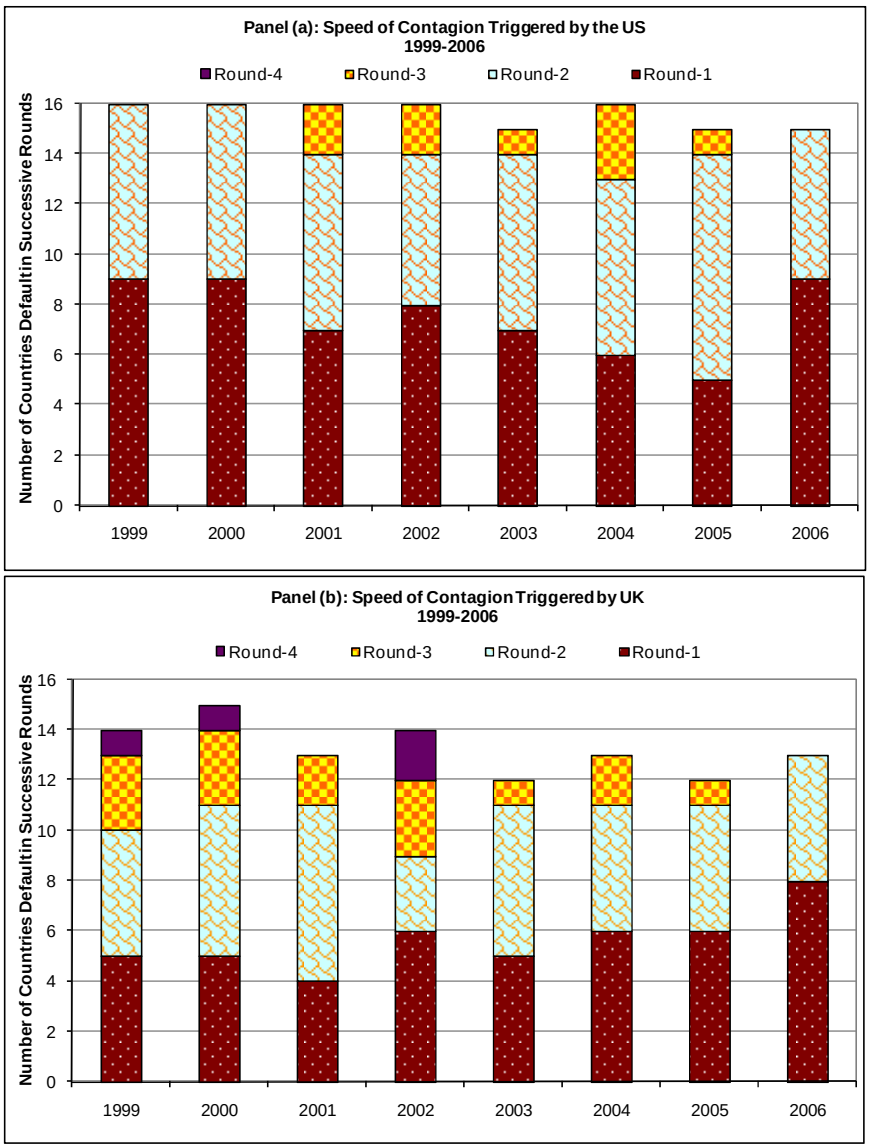


Figure 3.5 shows the number of recipient countries in each round. Segments in columns represent the number of countries that default in each round. Panel (a) depicts the contagion effect due to the US whereas panel (b) reflects contagion that is triggered from UK. The analysis is based on 100% LGD during 1999 and 2006.

Figure 3.6: Economic Impact of Contagion - All Banks are Internationally Exposed

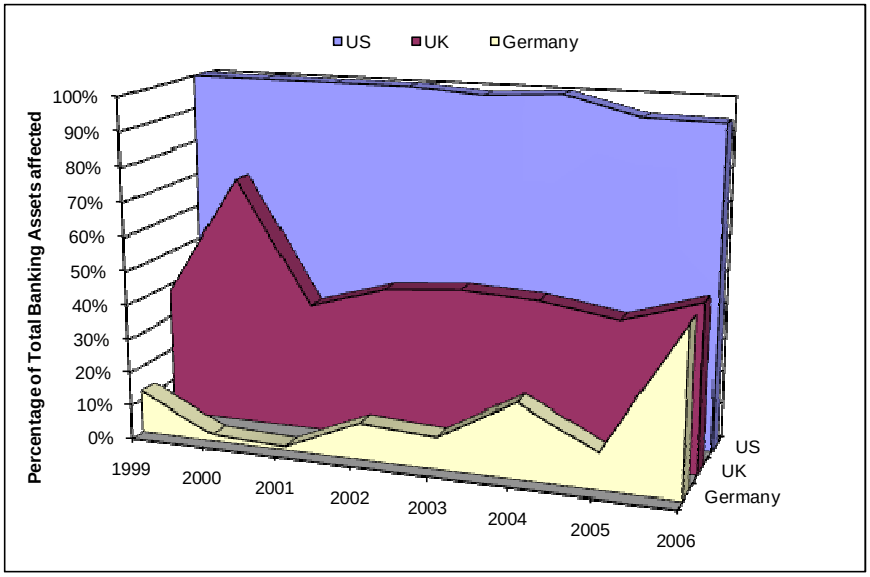


Figure 3.6 shows the economic impact of contagion that is triggered by the US, UK and Germany during 1999 and 2006. It is measured as the percentage of total assets of banking systems recipient countries relative to total assets of all banking systems (excluding triggering country). The analysis is based on 100% LGD

Figure 3.7: Systemically Important Shock

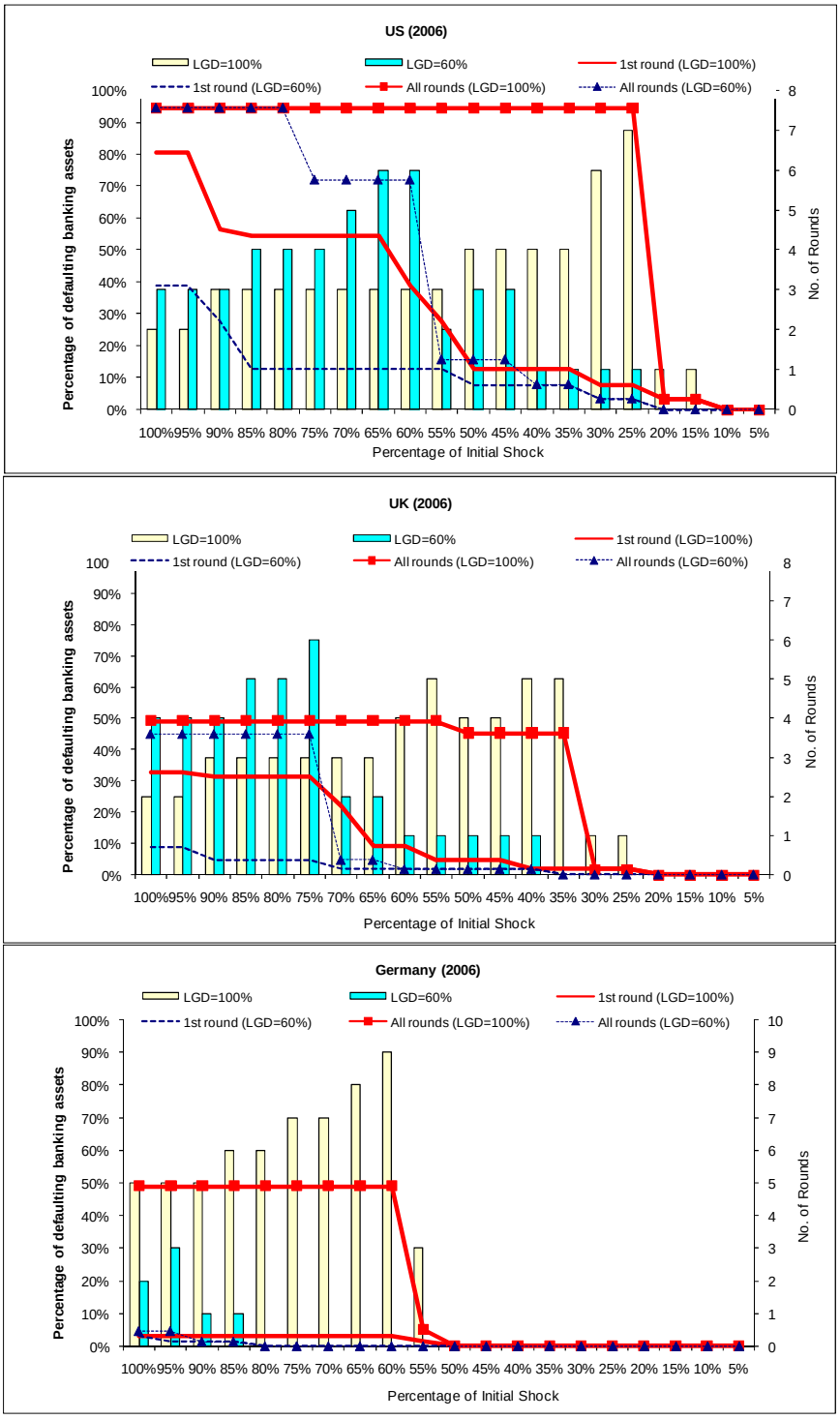


Figure 3.7 shows results for the exercise on a systemically important shock, for the US, UK and Germany at 100 percent and 60 percent LGD. The columns show the number of rounds, measured on the y-axis (right side). The lines show the percentage of total assets of defaulting banking systems relative to total assets of all banking systems (excluding triggering country), measured on the y-axis (left side).

Figure 3.8: Contagion Results Considering Only Short-Term Claims

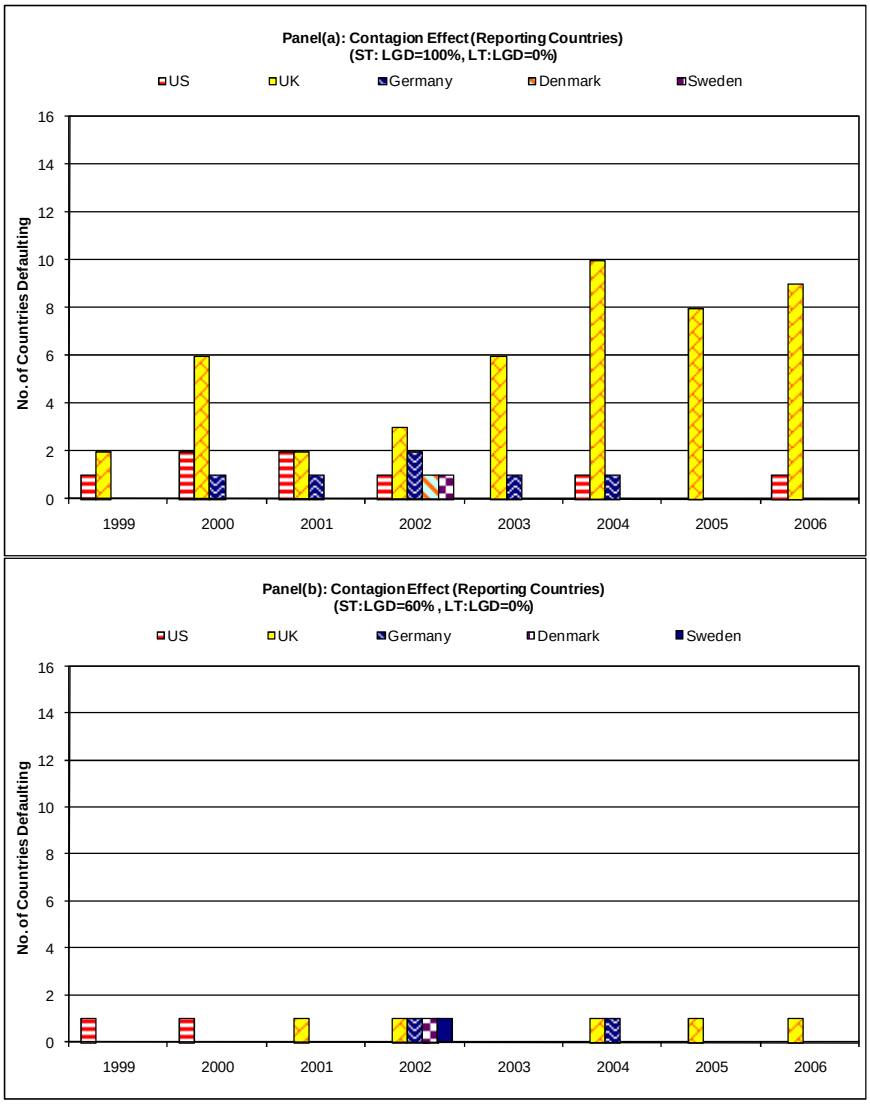


Figure 3.8 shows the contagion results due to the default of triggering country assuming different LGD on short-term liabilities and long-term liabilities. Each column depicts the number of recipient countries for the triggering country during 1999 and 2006. Panel (a) evaluates the effect with 100 percent LGD on short-term liabilities and 0 percent LGD on long-term liabilities. Whereas panel (b) evaluates the similar affect due to 60 percent LGD on short-term liabilities and 0 percent LGD on long-term liabilities.

Table 3.1: Foreign Claims of Reporting Banks to all 17 Countries

	AT	BE	CA	DK	FI	FR	DE	IE	IT	JP	NL	PT	ES	SE	CH	GB	US
Austria	---	1%	1%	0%	1%	1%	5%	2%	1%	0%	1%	1%	1%	0%	1%	1%	1%
Belgium	2%	---	1%	2%	1%	4%	2%	1%	8%	1%	7%	2%	3%	1%	1%	2%	3%
Canada	1%	0%	---	0%	1%	1%	1%	1%	1%	2%	2%	1%	0%	0%	1%	2%	8%
Denmark	1%	1%	0%	---	**28%**	0%	1%	1%	0%	0%	1%	2%	0%	**23%**	0%	1%	2%
Finland	1%	0%	0%	3%	---	0%	1%	1%	0%	0%	0%	0%	0%	**17%**	0%	0%	0%
France	5%	**11%**	2%	2%	2%	---	7%	5%	**14%**	6%	6%	**16%**	8%	2%	3%	9%	7%
Germany	**28%**	8%	3%	**12%**	6%	**10%**	---	**24%**	**14%**	**10%**	**14%**	7%	**10%**	**24%**	4%	7%	**16%**
Ireland	5%	6%	2%	4%	1%	2%	4%	---	5%	2%	2%	4%	3%	1%	1%	6%	2%
Italy	**10%**	9%	1%	1%	2%	**11%**	7%	8%	---	3%	7%	6%	7%	1%	2%	4%	5%
Japan	1%	1%	2%	0%	0%	**10%**	5%	3%	2%	---	3%	0%	0%	0%	7%	5%	**12%**
Netherlands	7%	**21%**	1%	2%	2%	5%	5%	2%	3%	3%	---	5%	4%	2%	2%	4%	7%
Portugal	1%	1%	0%	0%	0%	1%	1%	0%	3%	0%	1%	---	**11%**	0%	0%	1%	0%
Spain	2%	3%	0%	1%	1%	6%	5%	5%	5%	2%	5%	**20%**	---	1%	1%	4%	3%
Sweden	1%	0%	0%	**29%**	**34%**	1%	1%	1%	1%	1%	1%	1%	0%	---	0%	1%	1%
Switzerland	5%	1%	0%	2%	0%	3%	3%	1%	2%	1%	1%	2%	1%	1%	---	1%	3%
UK	**16%**	**20%**	**14%**	**32%**	9%	**17%**	**26%**	**35%**	**25%**	**12%**	**18%**	**18%**	**38%**	**13%**	**20%**	---	**30%**
US	**15%**	**14%**	**72%**	9%	**14%**	**28%**	**25%**	**10%**	**16%**	**56%**	**30%**	**14%**	**14%**	**13%**	**56%**	**52%**	---

Table 3.1 provides the distribution of foreign claims of reporting countries. Each column gives the percentage of foreign claims of a reporting country vis-à-vis other reporting countries averaged over time.

Table 3.2: Directly Exposed Banking Systems when All Banks are Internationally Exposed

Year 2006 (First Round) LGD=100%	Recipient Countries																	
Triggering Countries	DK	FI	SE	AT	BE	FR	DE	IE	IT	NL	PT	ES	CH	GB	JP	CA	US	Total
Denmark (DK)			■															1
Finland (FI)			■															1
Sweden (SE)	■																	1
Italy (IT)								■										1
Netherlands (NL)					■													1
Germany (DE)			■					■										2
UK (GB)	■		■		■		■	■		■		■	■					**8**
US			■			■	■	■		■			■	■	■	■		**9**
Total	2	0	**5**	0	2	1	2	**4**	0	2	0	1	2	1	1	1	0	24

Table 3.2 shows the details of directly exposed banking systems in 2006. For each triggering county (left column), the (defaulting) recipient countries are marked with a red box. The total on the right column gives total number of recipient countries for each triggering country. Whereas the total number of times a country defaults in the first round is mentioned at the bottom.

Table 3.3: Contagion Effect when all Banks are Internationally Exposed

Year 2006 (All Rounds) LGD=100%	Recipient Countries																	
Triggering Countries	DK	FI	SE	AT	BE	FR	DE	IE	IT	NL	PT	ES	CH	GB	JP	CA	US	Total
Denmark (DK)		■	■															2
Finland (FI)	■		■															2
Sweden (SE)	■	■																2
Italy (IT)	■	■	■	■	■	■	■	■		■	■	■	■	■		■		**14**
Netherlands (NL)					■													1
Germany (DE)	■	■	■	■	■	■		■		■	■	■	■	■		■		**13**
UK (GB)	■	■	■	■	■		■	■		■	■	■	■		■	■		**13**
US	■	■	■	■	■	■	■	■		■	■	■	■	■	■	■		**15**
Total	6	6	6	4	5	4	3	4	**0**	4	4	4	4	3	1	4	**0**	62

Table 3.3 shows the extent of contagion in 2006 taking into account all round effects when all banks are internationally exposed. For each triggering country (left column), the (defaulting) recipient countries are marked with a red box. The total on the right column gives total number of recipient countries for each triggering country. Whereas the total number of times a country defaults is mentioned at the bottom.

Table 3.4: Directly Exposed Banking Systems when Only Large Banks (more than $127 bn Assets) are Internationally Exposed

Year 2006 (First Round) LGD=100%	Recipient Countries																	
Triggering Countries	DK	FI	SE	AT	BE	FR	DE	IE	IT	NL	PT	ES	CH	GB	JP	CA	US	Total
Denmark (DK)		■	■								■							3
Finland (FI)			■								■							1
Sweden (SE)	■	■									■							2
Austria (AT)											■							1
Belgium (BE)											■							1
France (FR)					■			■		■	■		■					5
Germany (DE)			■	■				■		■	■		■					6
Ireland (IE)											■							1
Italy (IT)								■		■	■							3
Netherlands (NL)					■						■							2
Spain (ES)								■			■							2
Switzerland (CH)											■							1
United Kingdom (GB)	■		■		■		■	■		■	■	■	■			■		10
Japan (JP)											■		■					2
United States (US)	■		■	■	■	■	■	■		■	■	■	■	■	■	■		13
Total	3	2	**5**	2	4	1	2	**6**	0	**5**	**13**	1	**5**	1	1	2	0	53

Table 3.4 shows the details of directly exposed banking systems in 2006 when only large banks are internationally exposed. For each triggering country (left column), the (defaulting) recipient countries are marked with a red box. The black boxes represent additional contagion effect compared to previous case. The total on the right column gives total number of recipient countries for each triggering country. Whereas the total number of times a country defaults in the first round is

Table 3.5: Contagion Effect when Only Large Banks (more than $127 bn Assets) are Internationally Exposed

	Year 2006 (All Rounds) LGD=100%	Recipient Countries																	
		DK	FI	SE	AT	BE	FR	DE	IE	IT	NL	PT	ES	CH	GB	JP	CA	US	Total
Triggering Countries	Denmark (DK)		■	■								■							3
	Finland (FI)	■		■								■							3
	Sweden (SE)	■	■									■							3
	Austria (AT)											■							1
	Belgium (BE)											■							1
	France (FR)	■	■	■	■	■		■	■	■	■	■	■	■	■	■	■		15
	Germany (DE)	■	■	■	■	■	■		■	■	■	■	■	■	■	■	■		15
	Ireland (IE)											■							1
	Italy (IT)	■	■	■	■	■	■	■	■		■	■	■	■	■	■	■		15
	Netherlands (NL)	■	■	■	■	■	■	■	■	■		■	■	■	■	■	■		15
	Spain (ES)	■	■	■	■	■	■	■	■	■	■	■		■	■	■	■		15
	Switzerland (CH)											■							1
	United Kingdom (GB)	■	■	■	■	■	■	■	■	■	■	■	■	■		■	■		15
	Japan (JP)											■		■					2
	United States (US)	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		16
	Total	9	9	9	7	7	6	6	7	6	6	15	6	8	6	7	7	0	121

Table 3.5 shows the extent of contagion in 2006 taking into account all round effects when only large banks are internationally exposed. For each triggering country (left column), the (defaulting) recipient countries are marked with a red box. The black boxes represent additional contagion effect compared to previous case. The total on the right column gives total number of recipient countries for each triggering country. Whereas the total number of times a country defaults is mentioned at the bottom.

Table 3.6: Summary Statistics

	Capital to Asset Ratio			Foreign Claims to Asset Ratio		
	Mean	Median	St. Dev	Mean	Median	St. Dev
Austria	0.06	0.05	0.02	0.35	0.36	0.06
Belgium	0.11	0.11	0.01	0.38	0.38	0.04
Canada	0.04	0.04	0.01	0.21	0.20	0.03
Denmark	0.08	0.07	0.03	0.34	0.33	0.07
Finland	0.17	0.19	0.06	0.76	0.82	0.19
France	0.08	0.07	0.02	0.25	0.24	0.03
Germany	0.05	0.05	0.01	0.22	0.22	0.03
Ireland	0.06	0.05	0.01	0.53	0.53	0.17
Italy	0.09	0.09	0.02	0.39	0.38	0.04
Japan	0.05	0.04	0.02	0.06	0.06	0.01
Netherlands	0.09	0.09	0.02	0.41	0.40	0.04
Portugal	0.06	0.06	0.01	0.44	0.45	0.06
Spain	0.08	0.08	0.02	0.25	0.24	0.04
Sweden	0.07	0.07	0.02	0.38	0.36	0.07
Switzerland	0.10	0.09	0.02	0.38	0.38	0.05
UK	0.09	0.09	0.02	0.44	0.41	0.07
US	0.12	0.12	0.01	0.33	0.32	0.06
Total Sample	0.08	0.07	0.04	0.36	0.36	0.16

Table 3.6 reports descriptive statistics of capital to asset ratio and foreign claims to asset ratio averaged over time.

Table 3.7: Regression Results

	Model 1		Model 2	
Number of obs	2312		2312	
LR chi2(3)	759.94		785.59	
Pseudo R2	0.3768		0.3896	
Log likelihood	-628.35		-615.53	
PROBIT REGRESSION	**Coef.**	**Std. Err.**	**Coef.**	**Std. Err.**
Constant	-2.120 ***	0.111	-2.179 ***	0.158
Capital to Asset Ratio	-2.961 **	1.253	-2.752 **	1.287
Foreign Claims to Asset Ratio	1.498 ***	0.288	1.267 ***	0.297
Exposure to Trigger	10.127 ***	0.462	10.354 ***	0.470
Year Fixed Effect			YES	
MARGINAL EFFECTS	**dF/dx**	**Std. Err.**	**dF/dx**	**Std. Err.**
Capital to Asset Ratio	-0.557 **	0.236	-0.504 **	0.236
Foreign Claims to Asset Ratio	0.282 ***	0.054	0.232 ***	0.054
Exposure to Trigger	1.906 ***	0.113	1.898 ***	0.113
Year Fixed Effect			YES	

Table 3.7 reports probit regression results. The dependent variable is a binary number being 1 if country defaults and 0 otherwise.
** Significant at 5 percent
*** Significant at 1 percent

Table 3.8: Directly Exposed Banking Systems when a Country Defaults Only on Short-term Liabilities

Year 2006 (First Round) LGD=100%	Recipient Countries																	
Triggering Countries	DK	FI	SE	AT	BE	FR	DE	IE	IT	NL	PT	ES	CH	GB	JP	CA	US	Total
Denmark (DK)																		0
Finland (FI)																		0
Sweden (SE)																		0
Italy (IT)																		0
Japan (JP)																		0
Netherlands (NL)																		0
Germany (DE)																		0
UK (GB)																		**2**
US																		1
Total	0	0	0	0	0	0	0	1	0	0	0	0	**2**	0	0	0	0	3

Table 3.8 shows the details of directly exposed banking systems in 2006 when a country defaults only on short-term liabilities. We use the same set of triggering countries (left column) though only UK and the US trigger contagion in this case. The (defaulting) recipient countries are marked with a red box. The total on the right column gives total number of recipient countries for each triggering country. Whereas the total number of times

Table 3.9: Contagion Effect when a Country Defaults Only on Short-Term Liabilities

Year 2006 (All Rounds) LGD=100%	Recipient Countries																	
Triggering Countries	DK	FI	SE	AT	BE	FR	DE	IE	IT	NL	PT	ES	CH	GB	JP	CA	US	Total
Denmark (DK)																		0
Finland (FI)																		0
Sweden (SE)																		0
Italy (IT)																		0
Japan (JP)																		0
Netherlands (NL)																		0
Germany (DE)																		0
UK (GB)																		**9**
US																		1
Total	1	0	1	0	1	1	1	1	0	1	0	1	2	0	0	0	0	10

Table 3.9 shows the extent of contagion in 2006 taking into account all round effects when a country defaults only on short-term liabilities. We use the same set of triggering counties (left column), though only UK and the US trigger contagion in this case. The (defaulting) recipient countries are marked with a red box. The total on the right column gives total number of recipient countries for each triggering country. Whereas the total number of times a country defaults is mentioned at the bottom.

4 DETERMINANTS OF BANKING SYSTEM FRAGILITY - A REGIONAL PERSPECTIVE

This chapter focuses on regional banking system fragility and determines how common factors and banking system characteristics influence it. We also investigate the possibility of contagion within and across regions, and analyze whether banking system characteristics in the host region influence the magnitude of cross-regional contagion. We further investigate which banking system characteristics at the country level are important for an individual banking system to be in the lower tail when other banking systems in the region have joint occurrence of extreme low returns. We find that regional banking system characteristics play a significant role in explaining regional banking system fragility. We also find significant evidence for within region contagion in all regions but its effect is stronger in Latin America than in Asia. For cross-regional contagion, we find that the contagion effects of Europe and the US on Asia and Latin America are significantly higher compared to the effect of Asia and Latin America among themselves. We find that aggregate liquidity significantly reduces the contagion-effect from Latin America in Asia and from the US in Latin America. Concentration significantly reduces the contagion-effect from Europe in Asia, but it increases the contagion-effect from the US in Latin America. Asset diversity reduces the contagion-effect from Europe in Asia only. A better capitalized banking system in Latin America helps in reducing the contagion impact from the US. Lastly, we find that aggregate liquidity and banking system capitalization significantly reduce the probability of an individual country to be in the lower tail when other countries coexceed, both in Asia and Latin America.

4.1 INTRODUCTION

Banking system fragility significantly affects the flow of credit to economic agents, and possibly forces viable firms into bankruptcy across regions. Further, banking system fragility impairs the functioning of the payment system that may ultimately lead to economic stagnation (Demirgüç-Kunt and Detragiache (1997)). A fragile banking system affects neighboring countries in the region through cross-border linkages and raises concerns for regional banking system fragility. We refer to regional banking system fragility as a situation when a number of banking stock indices have jointly very low returns in the region. The recent financial crisis stresses the need for strict evaluation of regional banking system fragility from both policy makers and researchers. The focus of policy makers is to formulate policy recommendations to avoid such a

crisis in the future, whereas researchers are more interested in the determinants of regional banking system fragility.

Prudently regulating the banking system is undoubtedly a major objective for financial regulators because of the enormous cost of banking system instability. Hoggarth, Reis and Saporta (2002) estimate fiscal costs incurred in the resolution of 24 banking crisis in the last two decades and find that the cumulative output losses incurred during crisis periods are 15-20%, on average, of annual GDP. Therefore, a thorough understanding of the mechanism that can cause systemic banking crisis is a foremost challenge for a prudent financial regulator. In the extant literature on banking crisis, there are various reasons for imbalances that lead to banking crisis (see De Bandt and Hartmann (2000) for a comprehensive survey on systemic risk). Admittedly, each banking crisis is unique; but at the core they share similarities in the behavior of a number of economic variables and banking system characteristics that lead to crisis like situations. To address the core issues we need to focus on the behavior of the banking system as a whole because what may appear sound at the micro level may be quite fragile and flawed at the macro level (Hellwig (1994)). Acharya (2009) endogenously modeled systemic risk with correlation of returns on assets held by banks. He argues that the limited liability of banks and the presence of a negative externality of one bank's failure on the health of other banks give rise to a systemic risk-shifting incentive where all banks undertake correlated investments, thereby increasing economy-wide aggregate risk. Regulatory mechanisms such as bank closure policy and capital adequacy requirements that are commonly based only on a bank's own risk fail to mitigate aggregate risk-shifting incentives, and can, in fact, accentuate systemic risk.

In this regard, there have been concerted efforts to identify and measure the variables that determine regional banking system fragility. This is very challenging due to many reasons: 1) the extent of damages in the banking system is itself difficult to observe directly because the dividing lines between banks and other financial intermediaries have become blurred; 2) the spillovers between the banking systems abroad and the domestic economy are hard to assess but these spillovers are consistently affecting banking system stability in a region; 3) the strong inter-linkages of other sectors in the economy with the banking system can easily transmit imbalances in other sectors of the economy into the banking system and threaten its stability. Notwithstanding these difficulties, a number of researchers have made an attempt to assess the

fragility of banking system through 'stress testing' experiments. Their analysis is based on autocorrelation and survival time tests using historical data on bank failures and controlling macroeconomic conditions. The stress testing experiment at individual banks level (called micro stress tests) typically assesses a bank's position (balance sheet/profit) against a given exogenous change in a macroeconomic variable, e.g. a sudden rise in domestic interest rates. For an assessment of the banking system fragility, the aggregation of individual bank responses takes place without assessing the behavior of the banking system as a whole. Such an aggregation of individual responses is unable to incorporate indirect contagion effects due to interlinkages among economic agents within the whole economy. Therefore, it is vital to do macro stress test that relate to the entire system next to micro stress tests of individual banks (Goodhart (2006)).

Our approach analyzes the determinants of regional banking system fragility while controlling for common economic shocks. We are also interested in the extent of banking system contagion within region and across regions. Therefore, this chapter contributes to the empirical literature on cross-border contagion by evaluating contagion across regions. We define a region as a block of dominant banking systems in a continent. We consider four different regions in this chapter: these include 10 banking systems in Asia, 7 banking systems in Latin America, the US and Europe, each as one entity. It is important to mention here that we are interested in analyzing the regional banking system fragility in emerging market regions (i.e. Asia and Latin America). We use the US and Europe as triggering regions to evaluate cross-regional contagion from these regions on regional banking system fragility in Asia and Latin America. This is important because the recent financial crisis shows that the banking crisis in the developed world has severe implications for developed economies and emerging markets alike; however, the effect on developing countries is far from being thoroughly analyzed in existing literature.

We are mainly interested in evaluating the determinants of banking system fragility in a region; therefore, we do not explore the underlying transmission channels and focus on factors that determine the incidence of joint extreme negative returns of more than one banking systems in the region. More specifically, we follow Bae, Karolyi and Stulz (2003) to study regional banking system fragility through joint occurrences of negative extreme returns in banking system indices of multiple countries in the region. The joint occurrences of negative extreme returns are also called 'coexceedances'; hence both terminologies are used interchangeably. We analyze

whether regional banking system characteristics can explain regional banking system fragility (i.e. the number of banking systems having joint occurrences of extreme negative returns on a particular day) after controlling for common variables in a multinomial logistics settings. We focus on negative coexceedances because of its relevance for banking system fragility. Thus we evaluate the effect of a common shock within a region through the number of negative coexceedances and then extend this analysis for contagion from a shock in one region to other regions. A higher number of coexceedances in our analysis reflects the existence of systemic risk in the region. For example, in figure 4.1, we show anecdotal evidence that the number of coexceedances has significantly increased during crisis periods (i.e. Asian crisis 1997 and subprime crisis 2008). This indicates that our measures of daily coexeedances are also capturing the most important crisis periods. This is reassuring as it suggests that our fragility measure (i.e. the number of coexceedances) proxies for periods of banking system stress.

<please insert figure 4.1 here>

This chapter contributes to the existing literature in the following dimensions: 1) we evaluate banking system fragility through co-movements in banking stock indices that are measured on daily basis and provide a yardstick for instant evaluation of systemic crisis; 2) we assess the role of banking system liquidity, diversification of banking activities, banking competition, and the capitalization of the banking system; 3) we also investigate whether specific banking system characteristics in the host region help in reducing the probability of cross-border contagion (by interacting them with the number of negative coexceedances in triggering regions); 4) we explore another but related issue: under what conditions an individual banking system is in the tail with other countries and which regional and country level banking characteristics help to explain this event.

We find that banking system characteristics play a significant role in predicting banking system fragility next to the effects of common macro factors. Among the banking system characteristics, liquidity of banking system is the most important factor to reduce the probability of coexceedances in all regions, but the effect decreases in magnitude for the higher number of coexceedances in Asia and Latin America. The capitalization of the regional banking system also plays a significant role in reducing the probability of coexceedances in the region. Its effect is more profound in Latin America as compared to Asia. Regarding the impact of banking

competition, our findings are supportive of the competition-stability view in Asia and Latin America. We find that an increase in competition in the banking industry significantly reduces the probability of joint occurrences of extreme negative returns in both regions. Finally, we find that a focus on traditional loan making activities increases the likelihood of a single country in the bottom tail, but there is no significant impact on joint occurrences of extreme negative returns in the region.

We also find evidence for contagion in all regions. Its effect is stronger in Latin America than in Asia. Moreover, we find that contagion within region is higher in emerging market regions, in general, compared to developed regions. For cross-regional contagion, we find that the contagion effects of Europe and the US on Asia and Latin America are significantly higher compared to the effect of Asia and Latin America among themselves. More specifically, in Asia, the marginal effect is higher for cross-regional contagion from Europe, whereas in Latin America, the effect from Europe and the US is almost identical. Further, we find that the higher level of aggregate liquidity in the host region significantly reduces the cross-regional contagion.

We also explore whether a region's banking system characteristics help in reducing cross-regional contagion. We find that aggregate liquidity (in a narrow sense, i.e. cash) and capitalization in Asia reduce the impact of cross-regional contagion from Latin America. Moreover, diversity and concentration significantly reduce the magnitude of cross-regional contagion effect from Europe. For Latin America, we find that a higher liquidity (cash) and capitalization significantly reduce the magnitude of cross-regional contagion from the US.

Lastly, we investigate what banking system characteristics and/or common macro variables influence the likelihood of an individual country to coexceed when other countries in the region have joint occurrences of extreme negative returns. We find that aggregate liquidity and banking system capitalization significantly reduce the probability of that country's coexceedances in both Asia and Latin America.

The remainder of the chapter is organized as follows. In the next Subsection, we discuss our empirical hypotheses. Subsection 3 describes the data and variables used in the chapter and provide descriptive statistics. Subsection 4 explains methodology and the use of multinomial

logistic model. Subsection 5 presents our results. Subsection 6 discusses a few robustness tests. Finally, Subsection 7 concludes the chapter.

4.2 MOTIVATION FOR CONTROL VARIABLES AND REGIONAL CONTAGION

This chapter focuses on the fragility of the banking system in an entire region. We assess regional banking system fragility stemming from economic fundamentals and characteristics of the banking system. Following Bae, Karolyi and Stulz (2003), we include three common variables as a proxy for economic fundamentals, "regional conditional volatility", changes in the exchange rate, and interest rates. As regional banking system characteristics, we include banking system liquidity, diversification of banking activities, banking competition, and the capitalization of the banking system. Finally, we discuss the impacts of cross-regional contagion. We motivate each of these variables in the following sub-subsections.

4.2.1 Common shocks and regional banking fragility

There is an extensive literature that explores the relationship between stock markets and common variables. These variables include economic growth, inflation, interest rate level, financial leverage, stock trading activity and aggregate risk diversification. Kaminsky and Reinhart (1999) while analyzing the connection between banking crisis and balance of payment crisis (twin crises) reports that the loss of foreign exchange reserves, high real interest rates, low output growth and decline in stock prices are leading indicators of twin crises. Stock price volatility is closely associated with overall stock market performance. A number of recent studies assert that stock market volatility should be negatively correlated with stock returns (Whitelaw (2000), Bekaert and Wu (2000), Wu (2001) and Brandt and Kang (2004) theoretically and empirically argue that increases in stock market volatility increase risk and decrease stock returns). According to this strand of literature, the higher conditional volatility corresponds to a higher probability of a declining market that has a negative impact on portfolio returns in general. In our analysis, we expect that an increase in regional conditional stock market volatility will result in higher number of joint occurrences of extreme negative returns of banking indices. The effect comes through two possible channels; first, it may affect returns on banking stocks because of the negative relationship between stock market volatility and stock returns as stated earlier; and second, it may affect bank profitability through the increased likelihood of non-performing loans because of the higher leverage during volatile stock markets (see Ho-Mou (2009) for details on

the relationship between financial leverage and market volatility; and Ghosh (2005) for the relationship between financial leverage and banks' non-performing loans). To evaluate the impact of stock market volatility we incorporate regional conditional stock market volatility as an explanatory variable in our model.

Due to globalization, banks often are present in multiple regions along with exposures in different currencies. Therefore a sudden sharp depreciation of the domestic currency adds vulnerability to regional banking systems. Even though banks are often regulated to limit open positions in foreign currencies, sometimes it is not possible or desirable to hedge all open positions taking into account the cost of hedging. Large multinational banks that raise funds abroad and issue domestic loans denominated in foreign currencies, are often at high risk owing to an unexpected sharp movement in exchange rate. This notion has been extensively debated in the financial literature and there is significant evidence that exchange rate risk exacerbates banking system fragility during crises (Kaminsky (1999), (Kaufman (2000), Hutchison and Glick (2000)). We incorporate the average of daily exchange rate changes of all countries in the region as an independent variable in our model to check its effect on the probability of coexceedances of negative return on banking stock indices.

Banks mainly borrow funds for short-term and provide loans for long-term. If the maturity mismatch is not properly managed, it may significantly increase bank risk. Particularly, an increase in interest rates would deteriorate banks' balance sheets when they are unable to match a higher interest rate to depositors in the short run with fixed interest earned on long-term loan agreements. Even when banks pass on the higher interest rate to borrowers, their balance sheet may be affected because of higher occurrences of non-performing loans. Therefore, ceteris paribus, an increase in interest rates is likely to increase banking fragility. The interest rate level generally also controls for the effect of business cycle variables including domestic inflationary pressures, increase in foreign interest rates, shift towards tight monetary policy and lax regulatory framework owing to financial liberalization (Galbis (1995)). We introduce the interest rate as a control variable in our model.

4.2.2 Banking system characteristics and regional banking fragility

The structural characteristics of the banking sector also could play a role in systemic banking sector problems. We now motivate why the following characteristics of banking system are important:

4.2.2.1 Aggregate banking system liquidity

Banks provide liquidity on demand to both depositors and lenders. Banks exist as they are the most efficient liquidity providers in the economy (see e.g. Kashyap, Rajan and Stein (2002) or Gatev and Strahan (2006)). Individual banks maintain liquidity in order to withstand "normal" liquidity withdrawals from their customers. When their individual liquidity holdings are insufficient, banks turn to the interbank market or the central bank to obtain liquidity. Banking system liquidity in the interbank market therefore serves as a first line of defense against liquidity shocks. From a macro perspective, banks should maintain adequate levels of liquidity such that they are able to absorb any shock to banking system as a whole under different market conditions (Cifuentes, Shin and Ferrucci (2005)). The lack of aggregate liquidity at the banking system level may lead to a channel of contagion across banks and regions (see Allen and Gale (2000)). Further, aggregate liquidity effectively mitigates coordination failures in the interbank market and ensures financial stability (Karas, Schoors and Lanine (2008)). We therefore include aggregate banking system liquidity in our analysis, and investigate its impact on regional banking system fragility.

4.2.2.2 Diversification of banking activities

The lowered costs of information, advancement in telecommunications and deregulation of financial firms (the Second Banking Directive of 1989; and the Gramm-Leach-Bliley Act of 1999) gave rise to financial conglomeration in industrialized countries. The perceived benefits of conglomeration include revenue enhancement through product diversification; the ability to offer one-stop shopping to corporate clients and economies of scope in the production of financial services. De Nicoló, Bartholomew, Zaman and Zephirin (2004) provide evidence that financial conglomeration has increased globally between 1995 and 2000 both in terms of the proportion of conglomerate firms and of the proportion of assets held by financial conglomerates. Further, the financial conglomeration allows banks to move away from traditional commercial banking activities and offer a range of financial instruments according to their customers' needs. Whether

financial conglomeration that allows for diversification in banking activities create or destroy shareholders' value and leads to financial stability or not is an intriguing question addressed in many research studies (Laeven and Levine (2007), van Lelyveld and Knot (2009), Schmid and Walter (2009) Stiroh (2006); Baele, De Jonghe and Vander Vennet (2007)). Laeven and Levine (2007) find evidence for 'diversification discount' that financial conglomerates have lower market value than if those conglomerates were broken down into financial intermediaries that specialize in the individual activities. More recently, De Jonghe (2010) finds that banking system fragility, measured through an increase in banks' tail beta, aggravates when banks engage in non-traditional activities in addition to their core commercial banking activities. Since interest income is less risky than other revenue streams, it is argued that specialization in traditional activities result in lower systemic banking risk. In that sense, financial conglomeration is unable to reduce systemic risk. Wagner (2006) and Wagner (2010) theoretically argue that multiple activities of commercial banks though reduce risk at individual bank level, but from the financial system's point of view it raises the likelihood of systemic crisis because a shock that previously affect only a small part of the financial system, now affects a large portion of the system and possibly results in failure of the whole financial system. Thus the increase in similarities due to diversification facilitates contagion because the failure of one institution increases difficulties for other institutions with similar portfolios. The joint effect can be even bigger than the sum of individual effects. Given all the arguments above, we test whether diversification in banking activities increases or decreases regional banking fragility.

4.2.2.3 Competition in banking industry

The relationship between banking competition and financial stability is rather complex. Though the existing theory is about the competition and individual bank stability, but what we are doing here is not drastically different. We aggregate individual bank behavior at country level so that banking systems at regional level behave like individual banks at country level. For example, Allen and Gale (2004) argue that competition per se is not bad, sometimes it decreases stability and sometimes perfect competition is compatible with the socially optimal level of stability. Carletti and Hartmann (2003) have surveyed the competition-stability nexus in banking to report that the trade-off between competition and stability does not generally hold. The theoretical literature is also inconclusive on the relationship between competition and stability.

The “Competition-Fragility” theories - based on the idea of ‘charter/franchise value’ of the institutions, argue that more bank competition erodes market power and results in lower loan rate that decreases profit margins. Consequently lower revenues from performing loans, which provide a buffer against loan losses, make banks more risky and reduce their charter/franchise value. A higher franchise value deters bank risk taking as owners believe that their ownership of the bank is at risk in the event of insolvency. Therefore a lower franchise value reduces the value of ownership at stake and encourages banks to take on more risk for higher returns. This attitude of bank owners increases fragility of the banking system (Marcus (1984); Keeley (1990); Demsetz, Saidenberg and Strahan (1996)).

Alternatively, the “Competition-Stability” view suggests that more market power in the loan market may result in higher bank risk. The reasoning is that when banks charge higher loan rates to borrowers, it becomes harder for them to repay loans. This exacerbates moral hazard incentives of borrowers to engage in riskier projects and also result in a riskier set of borrowers due to adverse selection considerations (e.g. Boyd and De Nicolo (2005)). Competition is good for financial stability because more competition lead to lower interest rates, which in turn lead to lower probability of loan default, and hence safer banks. Furthermore, concentration results in few large financial institutions that are possibly engaged in high risk taking activities because of the believe that they are too-big-to-fail and are therefore more likely to be explicitly or implicitly protected by the government safety nets.

While presenting the above two views, Berger, Klapper and Turk-Ariss (2009) argue that the two strands of the literature are based on different set of assumptions. They need not necessarily yield opposing predictions regarding the effect of competition and market power on stability in banking. Even if market power in the loan market results in riskier loan portfolios, the overall risks of banks need not increase if banks protect their franchise values by increasing their equity capital or engaging in other risk-mitigating techniques. Similarly, adequate policies – such as risk-adjusted deposit insurance premiums – could mitigate any trade-off between competition and bank stability. Recently, Martinez-Miera and Repullo (2010) contribute to this literature and argue that there is a U-shaped relationship between competition and the risk of bank failure. In particular, they argue that the competition-stability view identified by Boyd and De Nicolo (2005) tends to dominate in monopolistic markets; whereas competition-fragility view dominates

in competitive markets. In other words, in very concentrated markets a new entry reduces the probability of bank failure, whereas in very competitive markets further entry increases the probability of failure.

On the empirical side, a recent contribution by Jiménez, Lopez and Saurina (2010) supports the 'charter-value' hypothesis using Lerner indexes (based on bank specific interest rates) to measure market power in the Spanish banking system. They find a negative relationship between market power due to concentration and bank risk i.e. low market power (competitive market) lead to high bank risk (banking system fragility). Beck, Demirguc-Kunt and Levine (2003) provide evidence for competition-fragility view through a dataset from 79 countries and assert that crises are less likely in more concentrated banking systems. Other studies provide evidence for the competition-stability view that bank risk increase with market power using different methodologies. Boyd, De Nicoló and Jalal (2007) and De Nicolo and Loukoianova (2007) both find that the Z-score, an inverse measure of bank risk, decreases with banking market concentration (measured using the Herfindahl-Hirschman index or HHI). Whereas Cihák, Schaeck and Wolfe (2006) use logistic model and duration analysis to prove that more competitive banking systems (measured using the Panzar and Rosse H-statistic) have lower likelihoods of bank failure and a longer time to crisis, and hence are more stable than monopolistic systems. To provide support to competition-stability view through comparison across countries, Uhde and Heimeshoff (2009) empirically investigate the impact of national banking market concentration on financial stability for the 25 Member States of the European Union over the period from 1997 to 2005. Using the Z-score, they report that Eastern European banking markets exhibiting a lower level of competitive pressure, fewer diversification opportunities and a higher fraction of government-owned banks are more prone to financial fragility whereas capital regulations have supported financial stability across the entire European Union.

4.2.2.4 Capitalization of the banking system

Ceteris paribus, a more capitalized banking system should be more stable because a higher capital base provides a cushion against insolvency. However, the prudential regulations regarding capital adequacy fail to ensure financial stability in an unambiguous manner (Eichberger and Summer (2005)). Although capital requirement regulations limit credit

exposures of a single bank with a weak equity base, past regulations did not deal with capital adequacy to control for systemic risk of the banking system as a whole. Since capital adequacy regulations have a focus on a single bank for implementation of law, they fail to incorporate the systemic risk on account of correlated portfolio positions in the banking system and domino effects in consequence of interbank exposures. Liu and Mello (2008) argue that fulfilling the capital requirements at individual bank level is not sufficient to prevent systemic crisis. They provide evidence from the recent subprime crisis, when financial institutions like Northern Rock, Bear Stearns and Lehman Brothers collapsed even though these institutions had capital buffers that appeared adequate before collapsing. Nevertheless, we expect that a larger capital base reduces the likelihood of contagion. We use the capital base of the banking system as a whole instead of focusing on bank capital for each bank. In our case, we evaluate whether the capital base of the banking system provide a cushion against regional banking system fragility.

4.2.3 Cross-regional contagion?

The re-emergence of crises during the 1990s (Mexican Peso Devaluation of 1994, 1997 Asian Crisis and 1998 Russian Crisis) already established the need for a critical evaluation of cross-border contagion that spread financial crisis from one country to another (Claessens and Forbes (2001)). The recent sub-prime crisis further endorses that cross-border contagion is a phenomenon that include not only neighboring countries in the region but also countries across regions (i.e. cross-regional contagion). The contagion can be fundamental-based (i.e. via trade or finance links) or 'pure' contagion, which arises when common shocks and all channels for potential interconnection are either not present or controlled for (Calvo and Reinhart (1996)). The argument in favor of fundamental-based contagion asserts that a higher degree of trade provides a transmission channel for contagion. Though we did not test regional integration directly in this chapter, it is true that higher level of coexceedances indirectly reflects regional integration. Actually the increase in regional integration provides one of the motivations for this chapter. We explore this using the bilateral trade among countries within a region (only exports are reported to avoid double counting) from UN Comtrade database. In appendix 4, we report that the trade value of total exports to individual countries has increased during our sample period except for the year 2008 due to global economic meltdown. We may take this anecdotal evidence to argue that the higher degree of economic integration within region in recent years

does incorporate synergies among regional banking systems on one hand, but it also increased the risk of regional cross-border contagion.

In literature we find evidence on the cross-border contagion that transmits an idiosyncratic shock in one national banking system to all banking systems in the region and threatens regional banking system stability. A shock can be transmitted via direct balance sheet interlinkages between financial systems. For example, Degryse, Elahi and Penas (2010) investigate contagion through direct cross-border linkages. They find that the failure of a banking system (hit by an exogenous default on foreign claims that are in excess of aggregate bank equity) can trigger domino effects in other countries that raise serious concerns for global financial stability. Bae, Karolyi and Stulz (2003) explore cross-regional contagion with focus on Asia and Latin America. They find significant evidence for the propagation of large negative returns across regions. More specifically, they find that contagion is more important in Latin America than in Asia; Latin America triggers more significant cross-regional contagion than Asia; and the US is largely insulated from contagion from Asia.

We also focus on regional cross-border contagion after controlling for common shocks and banking characteristics at regional level. There are empirical studies that explore cross-border contagion through co-movement of asset prices and test whether a change in asset prices in country A has some effect on asset prices in country B, using a number of econometric techniques (Baig and Goldfajn (1999); Forbes and Rigobon (2002); Bae, Karolyi and Stulz (2003); Corsetti, Pericoli and Sbracia (2005)). Some recent studies that concentrate on bank level data, also find evidence for cross-border contagion through co-movement of banking stocks (Gropp, Duca and Vesala (2009)). We also use co-movement of asset prices and follow the methodology of Bae, Karolyi and Stulz (2003) to extend the previous work on cross-border banking contagion towards cross-regional contagion.

In this chapter, we investigate contagion both within region and across region. We define contagion within region as the portion of regional banking system fragility (joint occurrences of extreme negative returns) that is not explained by the banking system characteristics and the regional common variables. For contagion across regions, we include indicators of regional banking system fragility in another region as an explicit independent variable in our model, whose marginal change reflects the extent of cross-regional contagion in banking systems.

4.3 DATA, DEFINITION OF VARIABLES AND DESCRIPTIVE STATISTICS

Since stock market valuations reflect future economic activity, a simultaneous decline in the value of stock indices in many countries in a region reflects an increase in financial fragility. Banks represent a major sector of the stock market; therefore, a simultaneous decline in banking stocks is a huge setback to regional financial fragility.[14]

The existing literature has complemented or sometimes even substituted traditional accounting data with stock market prices in assessing bank fragility (see e.g. Bongini, Laeven and Majnoni (2002), Gropp, Vesala and Vulpes (2004), Gropp, Vesala and Vulpes (2006), Yu-Fu, Michael and Kadri (2006)). In our analysis we use several countries' banking indices from Datastream starting from July 1, 1994 to December 31, 2008 (3784 daily observations). Datastream uses Industry Classification Benchmarks (ICB) for the construction of these indices. We include 10 Asian and 7 Latin American countries, following Bae, Karolyi and Stulz (2003). Moreover, we include the United States and Europe (as one entity) in our analysis to study the extent to which banking crisis in these regions affect banking system fragility in Asia and Latin America.

<please insert table 4.1 here>

Table 4.1 shows the number of banks included in the banking indices from each country. It also provides sample statistics including correlations for the full sample period. We find that the marginal daily return on banking indices varies across countries. The marginal daily return in the US is 0.041% and 0.035% in Europe. In Asia, China has the highest average daily return (0.089%), followed by Pakistan (0.073%) and India (0.072%). On the other hand, Indonesia has been the most volatile market in Asia with the highest daily return standard deviation i.e. 3.322%. In Latin America, Mexico led with 0.095% average daily return followed by Venezuela (0.085%) and Brazil (0.081%). Mexico and Argentina are among the most volatile markets in Latin America with standard deviations of 2.342% and 2.371% respectively.

Correlations among banking indices daily returns are higher within regions than across regions. For example, banking index daily return in Asian countries has 0.10 correlation among themselves compared to 0.05 against Latin America, 0.03 against the US and 0.13 against Europe. Moreover, we find that correlations are high among neighboring countries and more

[14] Banks included in the indices represent 20-35 percent of total market capitalization in our sample.

open economies in Asia. For example, Thailand, Philippines and Malaysia have high correlations in Asia that averaged around 14%. On the other hand, Argentina, Brazil, Chile and Mexico within Latin America have higher correlations that averaged around 27%. Moreover, because on a given day trading starts in Asia and ends in America, the information available in America at noon is not available to Asia on the same day. Therefore, in line with Bae, Karolyi and Stulz (2003), the previous trading day behavior in Latin America and the US is more relevant for Asia. This is evident from high correlation of daily return in Asian markets with the previous day's daily return in Americas. This is particularly significant for Asia and the US, for which, the correlation coefficient has increased from 0.03 to 0.14. For Latin America there is an increase from 0.05 to 0.06.

4.3.1 Exceedances and coexceedances

We follow the view that extremely low (negative) market returns on banking indices reflect fragility of the banking sector. To put things in a quantitative framework, we define an extreme event when the banking index return on that day lies below the 5th percentile of daily return distribution and refer to this as an exceedance of the return on the banking index. The distribution of the daily banking index return is directly observed from our dataset (3784 daily observations). From the distribution of 3784 daily observations of return on banking indices, we calculate 5th percentile value for each country and region and then use this value as a standard to decide whether a country or region on a particular day exceed or not. Moreover, we refer to coexceedances as a phenomenon when the banking indices of more than 1 country in the same region exceed on the same day. In table 4.2(a), we report the number of days for 0, 1, 2, 3, and 4 or more joint occurrences of extreme return (coexceedances) within a region on a particular day. We also indentify which countries "participate" in those extreme events and how often.

<please insert table 4.2(a) here>

As we are interested in banking system fragility, our focus is on joint occurrences of low extreme return (negative coexceedances). We nevertheless start by reporting joint occurrences of both low extreme returns (negative coexceedances) and joint occurrences of high extreme returns (positive coexceedances) separately. We have found an asymmetry between negative and positive extreme returns distribution in Asia and Latin America. In our sample, we find that there are 2497 trading days when there is no negative extreme return compared to 2451 trading days

when there is no positive extreme return in Asia. Similarly, there are 908 and 943 trading days when only one country witness extreme negative and positive returns in Asia respectively. In Latin America, there are 2832 and 2744 trading days of no negative and positive coexceedance respectively, whereas there are 719 and 829 trading days with one country in negative and positive tail respectively. The asymmetry in the distribution of extreme return is evident with 55 trading days when 4 or more countries in Asia are in bottom tail compared to 41 trading days when 4 or more countries in top tail. The asymmetry is even more in Latin America where 40 trading days when 4 or more countries in bottom tail compared to 21 trading days in top tail. Thailand has been the most recurring participant of the group of 4 or more countries in bottom as well as top tail. In Latin America, Argentina and Brazil are the most recurring countries in the group of 4 or more countries in the bottom or top tail. Beside Argentina and Brazil, Mexico often included in extreme events. On the other hand, Pakistan appears least number of times in negative extreme events within Asia. Venezuela is the least recurring country in extreme events in Latin America. We also report the daily return on the day of extreme event (4 or more countries coexceed) for all countries in our sample. We find that, In Asia, Indonesia, Korea, Pakistan, Thailand and India have above average negative return during negative extreme events. In Latin America, Argentina and Mexico have high negative returns during negative extreme events. We have also found that the absolute daily return is higher in top tail compared to bottom tail both in Asia and Latin America. Moreover, we have found clustering of coexceedances in 1998 and 2008 for Asia, whereas 1995, 1998 and 2008 in Latin America as shown in figure 4.1.

<please insert table 4.2(b) here>

Further, we investigate the distribution of coexceedances using Monte Carlo simulations in order to understand whether the existence of coexceedances can be explained by conditioning on large absolute value returns. To perform this task, we assume that the covariance matrix of returns is stationary over the sample period and that the returns follow a multivariate normal distribution. Using the observed covariance matrix, we simulate 1000 random realizations of the time series of 3784 daily returns for Asian and Latin American countries. For each realization we identify the extreme events in the same non-parametric count manner and then take average of all realizations. Results are shown in table 4.2(b), wherein we provide the actual and simulated mean of the number of occurrences for each coexceedances level (0, 1, 2, 3, and >=4). We find

that the actual values of extreme events are greater than simulated mean, which indicates the fat-tail behavior of extreme events.

<please insert table 4.2(c) here>

In this discussion, another relevant question would be whether banks have higher interlinkages than stock markets in general. As banks are more interconnected in international markets and therefore return on country banking indices should be more interdependent than the rest of the market, and therefore, we expect that banks have relatively more coexceedances than the market as a whole. In order to investigate whether the coexceedances in banking indices are in excess of the coexceedances in total market indices, we subtract the number of coexceedances in total market indices from the number of coexceedances in banking system indices for each daily observation in both Asia and Latin America as reported in table 4.2(c). We find that, in Asia, there are 520 days when the number of coexceedances in total market indices is greater than coexceedances in banking system indices; whereas 595 days when the number of coexceedances in banking indices is greater than coexceedances in total market indices. Similarly, in Latin America, 459 days when coexceedances in total market indices are higher; compared to 524 days when coexceedances in banking indices are higher. So, in general, we find that there are relatively more number of days when coexceedances in banking indices are higher than coexceedances in total market indices in both Asia and Latin America. This evidence is consistent with our conjecture that banks are more interconnected in the international market and hence returns on banking stocks tend to coexceed more than other stocks. Moreover, we have included the BIS data related to European and US banks foreign exposure on developing countries (that are included in our sample) to show the linkages of banking systems in developed and developing world. Please see appendix 2 for evidence on banks' foreign claims on regional countries.

4.3.2 Common variables

As we discussed in section 2, stock market volatility is expected to have an influence on regional banking system fragility. To investigate this econometrically, we estimate regional stock market volatility through indices that are representative of the capitalization of stocks that foreign investors can hold. More specifically, we use the International Finance Corporation (IFC) indices from Asia and Latin America, and the S&P 500 index for the United States and Datastream

International Europe Index for Europe in order to examine stock market volatility in each of these regions. For each region, we estimate the conditional volatility of the respective stock indices using a GARCH (1, 1) model of the form:

$$\sigma_{c,t}^2 = \alpha + \beta_1 \varepsilon_{c,t-1}^2 + \beta_2 \sigma_{c,t-1}^2 \quad (1)$$

using maximum likelihood, where $\sigma_{c,t}^2$ represents the conditional variance of the stock market index in country c in period t, and ε represents stock market returns in that market. In first column of table 4.3, we report the mean and standard deviation of conditional volatility of all countries in the region as well as regional conditional volatility over the entire sample period. Individual countries conditional volatility is calculated through their respective total market stock indices, whereas the regional conditional volatility is computer through IFC indices, S&P 500 and Datastream International Europe Index as reported earlier. We find that Korea has the highest and Sri Lanka has the lowest conditional volatility in Asia. In Latin America, Venezuela has the highest and Chile the lowest conditional volatility. At regional level, we find that the stock market in Latin America is more volatile with conditional volatility of 23.39 percent compared to 21.19 percent in Asia, 15.84 percent in the US and 15.03 percent in Europe.

<please insert table 4.3 here>

The second common factor that affects regional banking system fragility is the daily change in exchange rate. We calculate the daily change in exchange rate against US dollar for each country in Asia and Latin America. In case of the US, we use a basket of four currencies (i.e. GBP, JPY, CHF and EUR) to evaluate exchange rate changes. For Europe, since EUR and GBP are the two major currencies, we take equal-weighted average of EUR and GBP exchange rates changes against USD.15 We find that all currencies except Chinese Yuan in Asia and Latin America depreciated in our sample period. The most depreciated currency in Asia is Pakistani Rupee (0.026% daily) and Venezuelan Bolivar is the highly depreciated currency (0.080% daily) in Latin America. We use equal-weighted average of the daily changes in exchange rate of all countries in the region to get the regional change in exchange rate on that particular day. We find that Asian currencies, on average, depreciated less compared to currencies in Latin America,

[15] Since our sample starts from June 1994; therefore, we use country-weighted average of exchange rate against USD of euro currencies for daily observations prior to the introduction of EUR.

whereas, the US dollar and European currencies are appreciated, on average, during the sample period.

Finally, we explore the impact of the interest rate on regional banking system fragility. For regional interest rate, we compute equal-weighted average of 1-year interbank interest rate in countries within each region.[16] We find a high degree of heterogeneity in interest rates across countries in Asia and Latin America. In Asia, the lowest interest rate is observed in Taiwan (3.938% on average) and highest in Indonesia (13.361% on average). In Latin America, the interest rate is 0.498% in Chile and 21.488% in Argentina. At regional level, we find that interest rate is higher in Latin America than in Asia.

<please insert figure 4.2 here>

Figure 4.2 compares the trend of common factors in the sample period for Asia and Latin America. We find that conditional volatility increases significantly in both regions during the last two years, which is expected on account of turbulence in stock markets after the sub-prime crisis. The average change in exchange rate remains under 5 percent for most of time in our sample except for the crisis period (Asian crisis 1997 and Argentina crisis 2002). Lastly, we witness a general decline in interest rates in both regions till 2004 and then a slight increase during the last two years.

4.3.3 Banking system characteristics

Banking system fragility may hinge upon various banking characteristics including aggregate banking system liquidity, diversity in banking activities, competition in the banking sector and the capitalization of the banking system. We evaluate the effect of these banking characteristics on regional banking system fragility using annual balance sheet data for banks in each individual country from Bankscope.[17] We use consolidated banking statements because they are net of inter-office transaction between head-office and subsidiaries (inter-office transactions are not relevant for solvency of banks). Moreover, in chapter 2 of this thesis we use consolidated

[16] There exist high correlation between 1-year interbank market rate and policy rates (mainly discount rate but for some countries discount rate is not available so then use treasury bills rate as policy rates). The correlation coefficient is close to 0.9 for all economies except Chile and Venezuela with correlation coefficient is around 0.7.

[17] From *Bankscope*, we retrieve data for all banks from 1994 to 2008 for each region. We find that some banks report both consolidated and unconsolidated accounts in the bank scope. Therefore, in order to eliminate double entries, we use consolidated accounts when available, otherwise unconsolidated accounts.

accounting statements of all reporting financial institutions in Bankscope. If the consolidated statement is not available, then we use the unconsolidated/aggregate accounting statement, whatever is available. Similarly, if accounting statements are available on both IFRS and Local GAAP reporting conventions, then we use the former convention. In order to remain consistent we use the same approach in our calculation for aggregate equity in subsequent chapters. These variables are available on annual basis; therefore, we use the annual value of the preceding year for all daily observations of the current year. Moreover, the regional values are calculated by averaging individual country level data. For regional banking system characteristics we use the ratio of total banking assets of a country to the total banking assets of the region as weight. This captures the relative size and strength of a country's banking system in the region, therefore, the bigger the banking system of a country the more influence it should have at the banking regional level. Also, the large banking systems in the region should be more critical for the resilience of the regional banking system. On the other hand, we assign equal weights to macro shocks within a region, given that for country macro shocks, inter-country linkages can amplify or moderate the impact on the other countries real economy and therefore banking systems. Therefore we do not make any specific assumption.

In order to gauge the effect of banking system liquidity we use a narrow definition of liquidity, which is the ratio of cash and cash equivalent assets to total assets. We call this variable 'liquidity' hereafter. We find that banking system in India and Pakistan are holding high cash reserve relative to total assets. The cash holdings of India and Pakistan are 12.55 percent and 11.56 percent of the total assets respectively compared to 2.8 percent on average in Asia. Similarly, in Latin America, Venezuela holds 10.6 percent of the total asset as cash or cash equivalent compared to regional average of 2.88 percent. Secondly, we evaluate whether banking systems that are primarily involved in traditional loan-making activities are more or less prone to regional banking system stability. In order to measure the extent to which banks are involved in traditional loan-making activities compared to non-traditional activities, we calculate net loans to total earning assets for each country and label it as 'loans' in our results. We find that net loans are about half of the total earning assets in almost all countries; however, the focus on loan-making activities is slightly higher in Asia (53.96%) compared to Latin America (44.40%). In order to measure competition in banking industry, we use the ratio of total assets of biggest five banks to total assets of all banks (i.e. C5 measure) for each country in the region. We label it as

'concentration' in our analysis. The regional measure of concentration is the weighted average of individual country's concentration measure in the region using banking system total assets as relative weights. We find that banking systems in Asia are, on average, relatively more concentrated than the ones in Latin America. Sri Lanka, China and Pakistan are among most concentrated banking systems in Asia, whereas Peru, Venezuela and Chile are highly concentrated banking systems in Latin America. Lastly, the ability of banking systems to absorb foreign shocks depends on the degree of capitalization of the banking system. Our measure of capital is the total equity that includes common shares and premium; retained earnings; reserves for general banking risks and statutory reserves; loss absorbing minority interests; net revaluation of AFS securities; FX reserves included in equity and revaluations other than securities deemed to be equity capital. We find that banking systems in Asia, on average, maintain low capital to total asset ratio compared to Latin America.

<please insert table 4.4 here>

Table 4.4 shows the mean and standard deviation for banking characteristics for each country as well as at regional level during the whole sample period. We find that Latin America has more liquid asset as percentage of total assets compared to Asia. Moreover, Asia focus more on traditional banking activities (loan business), higher concentration in banking activities and relatively lower capital ratio compared to Latin America at regional level. As far as the time dimension is concerned, figure 4.3 shows that there is an increasing trend in liquid asset to total asset ratio in both Asia and Latin America. We also observe a decline in traditional banking activities (loan business) in both regions over time. There is no particular trend in concentration of the banking industry. Lastly, capital ratio has increased from around 8 percent to 10 percent in Latin America and hovered around 5 percent in Asia.

<please insert figure 4.3 here>

4.4 METHODOLOGY

The central question in the financial contagion literature is whether financial markets become more interdependent during a financial crisis. Formally, financial contagion occurs when a shock to one country (or a group of countries) results in propagation of the shock to a wide range of markets and countries in a way that is hard to explain only on the basis of changes in

fundamentals. During the nineties, researchers primarily investigated whether cross-market correlation increased significantly during financial crisis (Bertero and Mayer (1990), King and Wadhwani (1990), Calvo and Reinhart (1996), Baig and Goldfajn (1999)). Boyer, Gibson and Loretan (1999) and Forbes and Rigobon (2002) challenge the approach of contagion based on structural shifts in correlation. They argue that the estimated correlation coefficient between the realized extreme values of two random variables will likely suggest structural change, even if the true data generation process has constant correlation. They also point out the biases in tests of changes in correlation that do not take into account conditional heteroskedasticity. This motivates researchers to study contagion as a nonlinear phenomenon and introduce new techniques as for example, markov switching models (Ramchand and Susmel (1998) and Ang and Bekaert (2002)); extreme value theory (Longin and Solnik (2001) and Hartmann, Straetmans and Vries (2004)); and multinomial logistics model (Bae, Karolyi and Stulz (2003)). Markov switching models provide a consistent model to accommodate structural breaks in variance without any ad-hoc determination of the crisis period, but these models fail to converge when a number of explanatory variables are included (Abiad (2003)). On the other hand, extreme value models study the asymptotic distribution of conditional tail correlation that is characterized by very few parameters regardless of actual distribution. But to be asymptotically dependent, the random variables must be associated in the very tails of the distribution. Poon, Rockinger and Tawn (2004) could not find evidence of asymptotic dependence in daily stock market returns for the US, Japan, Germany and France after filtering the series from GARCH effects. An important conclusion of this work is that assuming asymptotic dependence can lead to serious overestimation of financial risks. Further, extreme value models do not allow control variables that are conditional on attributes and characteristics of the extreme events. On the other hand, the multinomial logistics models allow for the control variables that are measured with information available up to the previous day. These control variables are fundamental in analyzing contagion while conditioning the attributes and characteristics of the extreme events.

We use multinomial logistics models to assess how various banking systems are affected simultaneously following an external shock. This methodology has some advantages over correlation based methodology. It is focused on coexceedances that basically capture the comovement in extreme events (or in other words it reflects the correlation in volatility of banking indices). On the other hand, correlation based studies suffer from presumption that

contagion is based on linear measures of association for macroeconomic or financial markets events. There is ample evidence that crises increase both correlation and volatility (see Forbes and Rigobon (2002) for references), but correlation is a linear measure of dependence. In fact, extreme bad event leads to irrational outcomes, excess volatility and even panics; therefore, correlations based on linear association fails to capture these effects. Moreover, correlation gives equal weights to small and large returns; however, anecdotal evidences suggest that investors in panic like situation tend to behave irrationally while ignoring economic fundamentals and blindly following the market trends (i.e. large negative returns are more contagious than small negative returns). In short, correlation that gives same weight to large and small negative returns does not reflect the true market phenomenon. In fact, if extreme bad event lead to irrational outcomes, excess volatility and even panics; correlations based on linear association fail to capture these effects. Our study overcomes this problem. It focuses on coexceedances that basically capture the comovement in extreme events.

We are mainly interested in evaluating the determinants of banking system fragility in a region. We define fragility as the number of coexceedances in that region. A higher number of coexceedances (i.e. joint occurrences of extreme negative returns in banking indices) reflect more banking system fragility. Therefore, the dependent variable in our model is the number of coexceedances of banking systems in a region on a given day, which is a count variable. Given the evidence and arguments in Bae, Karolyi and Stulz (2003) and Gropp and Moerman (2004), we use a multinomial logistics model to explain the number of coexceedances in one region (the number of banking systems simultaneously in the tail) as a function of banking system characteristics while controlling for macro shocks. We also use the number of coexceedances in other regions (to capture cross-regional contagion effect) in our models. The general multinomial logistics can be illustrated as:

$$P_i = \frac{G(\beta_i' x)}{1+\sum_{j=1}^{m-1} G(\beta_j' x)} \qquad (2)$$

where x is the vector of covariates and β_i the vector of coefficients associated with the covariates, $G(\beta_i' x)$ is a logistic distribution and m is the number of categories in the multinomial model. The model is estimated using maximum log-likelihood function for a sample of n observations as follows:

$$logL = \sum_{i=1}^{n} \sum_{j=1}^{m} I_{ij} log P_{ij} \quad (3)$$

where I_{ij} is an indicator variable whose value is equal to 1 if the i^{th} observation falls j^{th} category and 0 otherwise. In our case, we have five categories i.e. 0, 1, 2, 3, and 4 or more banking systems coexceed in a region. Following the convention we define category 0 (i.e. no banking system exceed on a given day) as the base category and all coefficients are estimated relative to this base category. For the simplest case of constants only, we estimate four parameters. We introduce additional variable like conditional volatility, exchange rate changes, interest rate level, bank liquidity, diversity, concentration and capital ratio etc. in various models. But for each additional variable introduced in the model, we need to estimate four additional parameters. Moreover, the coefficients from discrete choice models are difficult to interpret, therefore, we report marginal effect that are obtained by differentiated the probability for each outcome with respect to unit change in independent covariate on a given day being evaluated at unconditional mean value of the independent variables. Since marginal effects in non-linear models are different for each set of data points in explanatory, we need to be careful in making inferences based on single set of observations (see Kolasinski and Siegel (2010) for recent discussion on this issue). The marginal effect can sometimes even change signs; therefore, we compute the response of probability measures to the full range on values of independent variables. The sum of probabilities of all five categories must equal to 1 and we show the responses of probabilities across whole range of independent variables through "coexceedances response curve".

In order to evaluate the cross-border contagion across regions, we introduce the number of coexceedances in other region as an independent variable. After controlling for the common shocks, a positive impact of coexceedances in other region would signal cross-regional contagion. We further investigate whether banking characteristics in the host region help in alleviating cross-regional contagion. We do this through interaction of the banking characteristics with the coexeedances in other regions.

4.5 RESULTS

We evaluate the state of banking system fragility in a region through the number of coexceedances in that region. A higher number of coexceedances (i.e. joint occurrences of

extreme negative returns in banking indices) reflect more banking system fragility. In section 3 we reported the number of coexceedances in Asia and Latin America. We now assess how banking system characteristics and macro factors affect the occurrence of such coexceedances. We also explore the extent of contagion within region and across regions. Lastly, we investigate what makes it more likely that an individual country will experience extreme negative returns together with other countries.

<please insert table 4.5 here>

Table 4.5 provides estimation results of the number of coexceedances within a region with macro control covariates using a multinomial logistic model. The left panel provides estimates for Asia and the right panel shows results for Latin America. In the first column we report the number of negative coexceedances and relative frequencies. Since there are no covariates, the relative frequencies represent the probabilities of the respective outcomes. We find that during our sample time period there is a probability of 65.99% that no Asian country has extreme negative return on a given day, whereas the extreme event when 4 or more countries coexceed has a probability of 1.45%. Latin America, where negative extreme returns are relatively low, has slightly higher probability of no exceedances (i.e. 74.84%) and relatively lower probability of 4 or more coexceedances (i.e. 1.06%). We should be cautious with comparing the number of coexceedances in Asia and Latin America as the number of countries included in our analysis is different for the two regions (i.e., we have 10 countries from Asia and 7 countries from Latin America). Moreover, we find that the joint occurrences of extreme negative returns are clustered in the period of financial crisis (i.e. Asia crisis in 1998 and sub-prime crisis in 2008).

4.5.1 Effect of common factors on regional banking system fragility

A higher number of coexceedances reflect banking system fragility, but in this section we try to explain banking system fragility through changes in common covariates. In relation to whether volatility drives coexceedances, our regressions in table 4.5, show that conditional volatility is one of the determinants of coexceedances. We add conditional volatility at the regional level as a common covariate. The results are shown as 'Model 1' for each region in table 4.5. We find that an increase in the conditional volatility significantly increases the probability of all exceedances in all regions and the effect decreases for higher number of joint occurrences. Moreover, we find that the economic magnitude is higher compared to Bae, Karolyi and Stulz (2003), which is due

to the fact that we are focusing on banking indices that are more volatile compared to general stock market indices. We find that a 1 standard deviation increase in conditional volatility (see table 4.3 for the magnitude of standard deviation) increases the probability of 1 exceedance by 0.046% and the probability of four or more coexceedances by 0.009% in Asia. All the partial derivatives are significant at 1% level and pseudo-R2 is 4.37%. Similarly, in Latin America, 1 standard deviation increase in conditional volatility increase the probability of 1 exceedance by 0.028% and the probability of four or more coexceedances by 0.004%. All marginal probabilities are significant at 1% level and pseudo-R2 is 4.08%. It shows that the economic significance of the effect of conditional volatility on joint occurrences of extreme negative returns is much higher in Asia compared to other regions.

The exchange rate mechanism and monetary policy conditions (being translated through interest rate level) are crucial elements for banking system stability. We include the average exchange rate change in the region and the average interest rate level in the region as independent variables to check the significance of these variables on banking system fragility. More specifically, we test the hypothesis that the fall in domestic currencies and higher interest rate level, on average, indeed lead to more coexeedances in the region. The estimates are shown as 'Model 2' in table 4.5. We find that currency depreciation aggravates banking system fragility in all regions; however, the economic magnitude of currency depreciation is much higher in emerging regions (Asia and Latin America). We find that 1 standard deviation fall in domestic currency value would increase the probability of 1 exceedance by 0.018% and 0.025% in Asia and Latin America. Similarly, for the extreme event of four or more coexceedances, a 1 standard deviation increase in average exchange rate in the region would increase the probability by 0.003% and 0.001% in Asia and Latin America respectively. Also, tight monetary policy in the region tends to deteriorate banks' balance sheets. Therefore, we would expect that higher level of interest rates increases the probability of joint occurrences of negative extreme returns in banking indices. Our results are in line with our expectations in Asia and Latin America. In terms of economic magnitude, we find that 1 standard deviation increase in interest rate level increases the probability of 1 exceedance by 0.032% and 0.027% in Asia and Latin America respectively. It increases the probability of four or more coexceedances by 0.004% and 0.001% in Asia and Latin America respectively. The inclusion of average change in exchange rate and average

interest rate level increases the pseudo-R2 from 4.37% and 4.08% to 6.58% and 5.55% in Asia and Latin America respectively.

In sum, we find that an increase in regional conditional stock market volatility, a fall in currencies and a rise in interest rate levels significantly increase banking system fragility in Asia and Latin America. In terms of economic significance, we find that banking system fragility in Asia has been affected most by these covariates. Moreover, we find that the common variables collectively explain very little variation of joint occurrences of extreme negative return in less developed regions (pseudo-R2: 6.58% and 5.55% in Asia and Latin America respectively). Moreover, we find that the effect of common shocks on regional banking system fragility has the same directions as we find in Bae at al (2003); however, the magnitude of the marginal effects are different for banking coexceedances and total market coexceedances. More specifically, by comparing our results with Bae et al (2003) results that use coexceedances in total market indices, we find that the marginal effects of conditional volatility and exchange rate are higher for total market indices (Bae et al (2003)); whereas, the marginal effect of interest rate is higher on banking system fragility compared to total market indices.

4.5.2 Effect of banking system characteristics on regional banking system fragility

The central question of this chapter is whether the regional banking system characteristics matter in safeguarding banking system stability. In particular, we assess the role of banking system liquidity, diversification in banking activities, competition in the banking industry and capitalization of the banking system. These characteristics are obtained from banks' balance sheets on an annual basis and we repeat the values of the preceding year in all daily observations in the current year. We include these regional banking system characteristics in our multinomial logistic regressions and also control for the effect of common macro factors. We use the number of coexceedances in the region as dependent variable and introduce banking system characteristics one by one in successive models while controlling for common macro factors. For reasons mentioned earlier, we are more interested in the analysis of banking system fragility in emerging markets of Asia and Latin America. In table 4.6 we report our estimation results, wherein panel (a) provides estimates for Asia and panel (b) shows results for Latin America.

<please insert table 4.6 here>

4.5.2.1 Aggregate Banking System Liquidity

In Subsection 2.2., we have argued that banking system liquidity serves as a buffer against liquidity shocks. A reasonable level of aggregate banking system liquidity is important for individual banks to get funds from the market without paying extraordinary premiums. This also discourages parking of funds for short-term benefits and improves market-participants resilience on interbank activities. Resultantly, this improves the efficiency of interbank market at country and regional level, thus reduces the chances of coexceedances. We test this hypothesis by investigating whether the banking system liquidity significantly affects the probability of joint occurrences of extreme negative returns. We use a narrow definition of liquidity that includes cash and cash equivalent as percentage of total assets (we label it as 'narrow liquidity' in our analysis). In model 1 of table 4.6, we report the effect of the narrow liquidity on joint occurrences of extreme negative return while controlling for all common macro factors. We find that a higher liquidity significantly reduces the probability of coexceedances in all regions. But the effect decreases in magnitude for a higher number of coexceedances. Moreover, the effect in Latin America, in comparison to Asia, is higher for 1 exceedance but is lower for 2 or more coexceedances. Our results are in line with Karas, Schoors and Lanine (2008) argument that availability of liquid assets at aggregate level can effectively mitigate coordination failures in the interbank market and ensure financial stability. More specifically, we find that 1 standard deviation increase in liquidity of banking system decrease the probability of 1 exceedance by 1.713% and 3.221% in Asia and Latin America respectively. The same change decreases the probability of 4 or more coexceedances by 0.443% and 0.276% in Asia and Latin America respectively. With the inclusion of liquidity of banking system, the pseudo-R2 has increased to from 6.5% and 5.5% to 8% and 7% in Asia and Latin America respectively. We also check the robustness of our results employing a broader definition of liquid assets (that includes cash and cash equivalents, listed securities, treasury bills, other bills, bonds and equity investments). We label it as 'broader liquidity'. We find that banking systems in Latin America, on average, are more liquid compared to banking systems in Asia. Liquid assets represent 32 percent of total assets in Latin America and 21 percent in Asia. The effect of broader liquidity on regional banking system fragility is significant for up to 3 coexceedances in Asia and up to 2 coexceedances in Latin America (model 1A, table 4.6). The effect is more significant in Asia

because Asian banking systems have relatively high securities investments that are volatile during period of market turbulences and raise the probability of extreme low returns.

4.5.2.2 Diversification in Banking Activities

Prior research provides significant evidence for a 'diversification discount', which means that financial conglomerates have lower market value than if those conglomerates were broken down into financial intermediaries that specialize in the individual activities (Laeven and Levine (2007)). Moreover, banking system stability reduces when banks engage in non-traditional activities in addition to their core commercial banking activities (De Jonghe (2010)). Noninterest income, particularly trading, is quite volatile and the correlation between net interest income and noninterest income is rising as product lines blur and banks increasingly substitute nontraditional sources of income for interest income. This means that the banking industry may not realize the reduction in volatility and risk that some are expecting (Stiroh (2004)). Therefore, it is argued that specialization in traditional activities results in lower systemic banking risk. In that sense, financial conglomeration is unable to reduce systemic risk similar to Wagner (2006) theory that diversification reduces risk at individual institution level, but from the financial system's point of view it just reallocate risks among institutions within the financial system and tend to expose each institution to the same external shocks.

In our analysis, we started with the Laeven and Levine (2007) measure of diversity in banking activities in our multinomial logistics model. We label it as 'asset diversity' in our analysis. They define asset diversity as follows:

$$1 - \left| \frac{(Net\ Loans - Other\ Earning\ Assets)}{Total\ Earning\ Assets} \right| \qquad (4)$$

where other earning assets include securities and investments and total earning assets is the sum of net loans and other earning assets. This measure can take values between 0 and 1 with higher values indicating greater diversification. In the extreme case with net loans equal to other earning assets, this measure is equal to 1 representing full diversification. On the other extreme, the no diversification case is a bit tricky as the measure takes 0 values when the banking system is either completely specialized in loan activities or issues no loans at all. In short, the measure gives the overall level of diversification in banking activities but does not provide information about holding portfolios. Though banks are historically involved in loan-making activities, the

concept of financial conglomerate has tremendously increased the scope of financial services that banks offer nowadays. This measure gives diverging results in our analysis. We find that a higher degree of asset diversity reduces the probability of coexceedances in Asia, and increases the probability of coexceedances in Latin America (model 2, table 4.6). These diverging results are not necessarily surprising because this measure, in the case of low diversification, is unable to differentiate whether a banking system concentrates on loan-making activities or other activities. Our conjecture for the different signs of asset diversity measure in Asia and Latin America is that banking systems in Asia are more centered on loan-making business than in Latin America. We already reported that Asian banking systems, on average, have higher net loans relative to other earning assets (i.e. 54 percent of total earning assets); whereas banking systems in Latin America, on average, have lower net loans relative to other earning assets (i.e. 44 percent of total earning assets). Therefore, it can be argued that banking systems in Latin America are relatively less involved in loan-making activities, so further diversification tends to increase loan making activities and thus increase the likelihood of a banking system being in the bottom tail. Therefore, based on our findings, we cannot support the argument that diversification tends to increase banking system fragility when banks have low net loans compared to total earning assets. But our findings are based on regional analysis, while other studies use country level data to corroborate that traditional banking activities result in lower systemic banking risk.

As an alternative to the asset diversity measure suggested by Laeven and Levine (2007), we use loan to total earning assets ratio as a proxy for banks' focus on traditional loan-making activities (i.e. level of diversification).We label it as 'loan-ratio' in our analysis. In that sense, it is expected that an increase in loan making activities as percentage of total earning assets would reduce the probability of fragility in the financial system. In model 2A of table 4.6, we report the effect of diversification in a particular region on the joint occurrences of extreme negative returns in that region. We find that an increasing focus on traditional loan making activities increase the likelihood of a single country exceeding. However, it has no significant impact on a higher number of coexceedances. Wagner (2006) further argues that similarities among financial institutions unambiguously raises the likelihood of systemic crisis because a shock that previously affect only a small part of the financial system, now affecting a large portion of the system and possibly result in failure of the whole financial system. Thus the increase in

similarities due to diversification facilitates contagion because the failure of one institution increases difficulties for other institutions with similar portfolios. The joint effect can be even bigger than the sum of individual effects. To investigate this issue further, we incorporate the heterogeneity in focus on banking activities across countries in a region as explanatory variable. This heterogeneity is measured through the standard deviation of loan/total earning assets ratio across countries for each individual trading day. We label it as 'country heterogeneity' in our analysis. We find that more heterogeneity in the loan/total earning assets ratio deteriorates regional banking system stability in Latin America (model 2B, table 4.6).

4.5.2.3 Competition in Banking Industry

Similar to diversification activities, the literature on the effect of banking competition on banking system stability is inconclusive. As discussed in Subsection 2.2, two views exist, the competition-fragility view and the competition-stability view. One may argue that these views are about competition and individual bank stability, but not regional banking system stability. Indeed the theory is not specifically about the effect of competition and bank stability at the regional level. But what we are doing here is not drastically different from those models. We aggregate individual bank behavior at the regional level. If the aggregation is correct, banking systems at the regional level should behave as theory predicts.

Our findings are supportive of the competition-stability view. We gauge competition in banking industry through C5 measure of the level of concentration, which is the ratio of total assets of the largest five banks to total assets of all banks. We label it as 'concentration' in our analysis. The estimates are shown in model 3 of table 4.6. We find that higher level of concentration in banking industry significantly increases the probability of 1 and 2 coexceedances in both Asia and Latin America. Moreover, in Latin America, the increase in concentration also increases the likelihood of four or more coexceedances. In terms of economic magnitude, we find that 1 standard deviation increase in concentration will increase the probability of 1 and 2 coexceedances by 4.106% and 1.012% respectively in Asia; and by 4.338% and 0.958% respectively in Latin America. These findings are true for both Asia and Latin America, but the impact is higher in Latin America. Our support for competition-stability view in Asia and Latin America may still be consistent with Martinez-Miera and Repullo (2010) U-shaped relationship between competition and the risk of bank failure. They argue that the competition-stability view

identified by Boyd and De Nicolo (2005) tends to dominate in monopolistic markets; whereas competition-fragility view dominates in competitive markets. We find that the monopolistic market structure in these regions (the five largest banks in the majority of the countries in Asia and Latin America hold 60 percent of total assets of the banking system), requires an increase competition for banking system stability, but we may be unable to identify the upward leg of the U-shaped relationship.

4.5.2.4 Capitalization of the Banking System

Bank capital provides a cushion against insolvency at individual bank level. But from a macro perspective, the capital adequacy regulations for individual banks fail to incorporate the systemic risk on account of correlated portfolio positions in the banking system and potential domino effects as a consequence of interbank exposures (Liu and Mello (2008)). With this notion we investigate whether regions with a higher aggregate degree of bank capital exhibit less banking system fragility. We use the total equity of the region-wide banking system instead of focusing on bank capital for each bank. We label it as 'capitalization' in our analysis. The results are reported as model 4 in table 4.6. We find that greater capital significantly reduces the probability of 2 coexceedances in Asia and up to three coexceedances in Latin America. However, we do not find any significant effect of greater degree of capitalization of the banking system on the probability of four or more coexceedances in Asia and Latin America. In sum, it seems that a better capitalized system reduces the likelihood of a lower number of coexceedances. In contrast, it does not dampen the likelihood of an extreme number of coexceedances. We also investigate whether the heterogeneity in bank capitalization among countries play a role in regional banking system fragility. Results are shown as model 4a in table 4.6. In Asia, we find that the heterogeneity in bank capitalization across countries would significantly increase the probability of banking system fragility in the region. However, in Latin America, there is no significant impact of heterogeneity in bank capitalization on regional banking system fragility.

4.5.2.5 Summary of the Effect of Banking System Characteristics[18]

We now summarize the effects of banking system characteristics on regional banking system fragility. We find that liquidity of banking system is the most important factor to reduce the

[18] We are cautious in interpreting these result (whether the deteriorating banking system characteristics increases the probability of coexceedances or higher coexceedances lead to the deterioration of banking system characteristics, the exact causality is not very clear in this regard).

probability of coexceedances in all regions, but the effect decreases in magnitude for the higher number of coexceedances in Asia and Latin America. The result is consistent with alternative definition of liquidity as well. The banking system capital also plays significant role in reducing the probability of coexceedances in the region; however, we find that the effect of capitalization is more significant in Latin America as compared to Asia. From the industry point of view, our findings are supportive of the competition-stability view in the monopolistic market structure in Asia and Latin America. We find that increase in competition in banking industry significantly reduces the probability joint occurrences of extreme negative return in both regions. The result is consistent with Martinez-Miera and Repullo (2010) argument that competition-stability view is dominant in monopolistic market structure. We also find that focus on traditional loan making activities though increase the likelihood of single country in bottom tail, but no significant impact on joint occurrences of extreme negative returns in multiple countries in the region. The inclusion of banking characteristics increases explanatory power of model in all cases, which suggest that these characteristics can predict banking system fragility in the region. The pseudo-R2 is around 0.08 in Asia and 0.07 in Latin America for most of the regressions reported in this section.

4.5.3 Contagion within region and across regions

We now investigate whether there is any evidence for contagion within region and across regions. We define contagion within region as the portion of regional banking system fragility (joint occurrences of extreme negative returns) that is not explained by the region's banking system characteristics and common variables. Contagion across regions is the portion of a host region's banking system fragility that is explained by the joint occurrences of extreme negative returns in other triggering regions, after controlling for the host region's common factors and banking system characteristics. We capture the impact of cross-regional contagion by including the number of coexceedances in the triggering region as an explanatory variable. Its marginal change reflects the extent of cross-regional contagion through an increase in probability of joint occurrences of extreme negative returns in host region by a unit increase in regional banking system fragility in triggering region.

In table 4.6, we also reported that McFadden pseudo-R2 with our estimations for the effect of banking system characteristics and macro factors on banking system fragility, which is around

8% in Asia and 7% in Latin America. This gives some idea that there is a considerable portion of joint occurrences of extreme negative return that is not explained by banking characteristics and common macro factors together. We find similar evidence of contagion within region as reported in Bae, Karolyi and Stulz (2003) that contagion differs across regions and it is stronger in Latin America than in Asia. Moreover, we find that the pseudo-R2 is substantially lower in the emerging market regions (Asia and Latin America); therefore, we argue that contagion within region is higher in emerging market regions, in general.

<please insert table 4.7 here>

For cross-regional contagion, we include the number of coexceedances in the triggering region as an explanatory variable. If the coefficients of these variables are positive and significant, after controlling for the host region's banking system characteristics and common macro factors, then we interpret this as the evidence of contagion from that particular triggering region. In order to evaluate the extent of contagion we take marginal change in coexceedances probabilities of the host region with respect to change in coexceedances in triggering region at the unconditional mean of the covariates. Following Bae, Karolyi and Stulz (2003), we use 1 day lag for the US and Latin American coexceedances in case of Asia, otherwise all coexceedances are contemporaneous. The results are reported in table 4.7. The upper panel reports the contagion effect to Asia from coexceedances in other regions. We find significant cross-regional contagion in Asia. The contagion effects in Asia from Latin America, Europe and the US are reported as Model 1, Model 2 and Model 3 respectively. Model 4 reports contagion effect from all triggering regions simultaneously. The cross-regional contagion effect is significant at 1 percent level for all number of coexceedances when it is triggered from the US; whereas, the contagion triggered from Latin America and Europe have significant effect on 2 or more coexceedances in Asia. For economic significance, we find that the US, on average, has the highest contagion effect to Asia. Similarly, the contagion effect to Latin America is reported in lower panel of table 4.7. The cross-regional contagion from all regions is significant for any number of coexceedances in Latin America at 1 percent level. However, the economic impact is low in case of contagion from Asia compared to the US and Europe, which makes sense due to geography and economic ties of Latin America with the US and Europe. In short, we find that a significant cross-regional contagion effect from all regions but the magnitude differs across regions. In particular, the

effects of Europe and the US on Asia and Latin America are significantly higher compared to the effect of Asia and Latin America among themselves. More specifically, in Asia, the marginal effect is higher for cross-regional contagion effect from Europe, whereas in Latin America, the effect from Europe and the US is almost identical.

4.5.4 Response curves of the effect of regional and contagion variables on banking system fragility

In line with Bae, Karolyi and Stulz (2003) we analyze "coexceedances response curves" to assess the impact of covariates on the probability of coexceedances. These response curves provide a complete picture of the effect of changes in covariates on the probability of exceedances compared to the above-mentioned partial derivative that are estimated at the means of the regressors because the probabilities are not linear functions of the regressors. We examine the effect of common/macroeconomic variables on negative coexceedances of banking systems in a region. We separately plot the probability of coexceedances as a function of each common factor and banking system characteristic over the whole relevant range. These plots permit us to better assess how the probability of coexceedances are affected by changes in regressor. The different areas of the plot correspond to different coexceedances levels. Plotting the probability of exceedance as a function of the regressor over the whole relevant range of the regressor. Figure 4.4a and 4.4b provide coexceedances response curves of Asia for common factors and banking system characteristics respectively. Similarly, figure 4.5a and 4.5b show the coexceedances response curves for Latin America.

<please insert figure 4.4 and figure 4.5 here>

We find that the curves are highly nonlinear that support the use of a multinomial logistic model. The increase in conditional volatility strongly increases the probability of all coexceedances throughout the continuum both in Asia and Latin America. The exchange rate changes play a significant role only if it exceeds a certain threshold level. The subtle increase in exchange rate has negligible impact on the probability of coexceedances, whereas the effect on probability of coexceedances increases exponentially with the increase in magnitude of exchange rate changes. Lastly, the increase in interest rate level has almost a linear effect on the probability of coexceedances. As far as the magnitude is concerned, we find that only higher interest rate level can significantly increase probability of coexceedances. With regard to banking system

characteristics, we find that aggregate liquidity will reduce the probability of all coexceedances in the entire range in Asia and Latin America. We observe a flat curve for the effect of banking system capitalization in Asia; whereas in Latin America, it will significantly reduce the probability of coexceedances. The non-linearity in coexceedance curve is due to the probability response of changes in common factors are dependent upon the current level of the common factors. This is important because the banking system fragility is an extreme event and the effect of macro factors under extreme condition is not the same as it could be under normal circumstances.

4.5.5 Banking characteristic in host region and cross-regional contagion

We reported earlier that contagion within region has higher likelihood in emerging market regions than in developed regions. The next interesting question to ask is whether the banking system characteristics in emerging market regions have any influence on the cross-regional contagion effect. We specifically investigate whether the host region's level of aggregate liquidity, diversification, competition, and capitalization dampen cross-regional contagion. We expect that higher liquidity and capitalization of the host region provide better support against cross-regional contagion; whereas the effect of diversification in banking activities and competition in banking industry on cross-regional contagion is ambiguous. In order to test econometrically, we extend our multinomial logistics model of cross-regional contagion with interactions of the cross-regional contagion variable and the host region's banking system characteristics in successive models.

The measurement of interaction effect in nonlinear models is not straightforward as Ai and Norton (2003) argue that it is not equal to the marginal effect of interaction term. They provide an alternative measure, but the magnitude of interaction effect as well as its standard error is different for every data point and is generally nonzero even for a model with no interaction term. This makes it impossible to draw an overall statistical inference for the sample using the Ai and Norton measure (Greene (2010)). Similarly, there is a disagreement among applied econometricians about interpretation of the interaction effect. Some use interaction term coefficient alone to draw inference about interactive effect while others find it incorrect. They argue that the cross partial derivative of the probability of occurrence with respect to interacted covariates can, for some observations, have the sign opposite to that of the interaction term

coefficient. However, Kolasinski and Siegel (2010) show that this sign flip results from a mechanical saturation effect that, in many cases, is of no importance to researchers primarily concerned with proportional, rather than absolute marginal effects. For such researchers, the interaction term coefficient provides a more meaningful measure of interactive effects than does the cross-partial derivative of the probability itself.

<please insert table 4.8 here>

Hence we report both the interaction term coefficient as well as the Ai and Norton (2003) measure without going into technical complexities. The upper panel of table 4.8 reports the results for Asia, whereas the lower panel provides evidence for Latin America when including interaction terms between contagion and regional host banking system characteristics. In general, we find that banking system characteristics in Asia tend to affect the magnitude of cross-region contagion when it is triggered from Latin America and Europe; whereas in Latin America, banking characteristics will affect the magnitude of cross-regional contagion from the US only. Moreover, liquidity and capitalization in the host region have more significant affect on the magnitude of cross-regional contagion compared to diversification and concentration. For example, aggregate liquidity (narrow) and capitalization in Asia will reduce the magnitude of the cross-regional contagion effect from Latin America; however, the interaction effects are statistically significant for 1 and 4 banking system coexceedances in Asian region. Moreover, diversity and concentration will significantly reduce the magnitude of cross-regional contagion effect from Europe. For Latin America, we find that a higher liquidity (cash) and capitalization will significantly reduce the magnitude of cross-regional contagion from the US.

In order to evaluate the behavior of interaction effect over the entire range of explanatory variable we construct the Ai and Norton (2003) measure (See appendix 1 for the details of Ai and Norton (2003) interaction effects and how to read their graphs). We construct a binary dependent variable that has value 1 when 2 or more coexceedances occur in the host region else 0. We check the interaction effects of all possible combinations of banking system characteristics and cross-regional contagion variables, but for the sake of brevity we report only significant interactions effects using graphs in figure 4.6. We find that the graphical evidence though support our earlier conclusion about the effect of banking system characteristics on the magnitude of cross-regional contagion effect, but it is more significant for lower predicted

probabilities of cross-regional contagion from triggering region to host region. This implies that when there is a strong likelihood of cross-regional contagion then banking system characteristics in the host region fail to affect its magnitude. More specifically, we find that liquidity in Asia will reduce the magnitude of cross-regional contagion effect from Latin America; whereas diversity and concentration will reduce the magnitude of cross-regional contagion effect from Europe (see panel (a) of figure 4.6). For Latin America, we find that banking system characteristics (liquidity, concentration and capitalization) will reduce the magnitude of cross-regional contagion effect from the US only (see panel (b) of figure 4.6).

<please insert figure 4.6 here>

4.5.6 Do individual country banking characteristics matter?

Acknowledging the fact that banking system stability at country level is as important as regional banking system stability, we investigate what banking system characteristics and/or common macro variables influence the likelihood of an individual country to be part of a coexceedance. For this analysis, we construct a binary dependent variable whose value is 1 when the country also coexceed with at least one other country in the region; else the binary dependent variable takes value 0. We use the same set of independent variables (macro variables as well as banking characteristics) as before but now these variables are observed both at country level and at the regional level. We use a probit model to estimate the probability of a country being part of coexeedances and control for common variables and banking characteristics at regional level. The upper panel of table 4.9 presents results for Asia and the lower panel shows results for Latin America. We find that the effect of common variables at country level is similar to the effect at regional level but their economic magnitude is much smaller.19

<please insert table 4.9 here>

In Asia, we find that aggregate liquidity20 is the most important factor that reduces the probability of an individual country to coexceed provided other countries are already coexceeding on a particular day. The results are consistent with aggregate liquidity both at regional level and at country level. Apart from aggregate liquidity, a higher level of banking

[19] We do not report these results for the sake of brevity.
[20] We use narrow definition of liquidity for country level analysis in both Asia and Latin America.

system capital at country level also significantly reduces the probability of that country's coexceedance even though regional banking system capitalization is insignificant. Moreover, we find that the concentration in banking industry at country level reduces the probability of that country to be included in the joint occurrence of extreme low returns. This is different from our earlier result that supports competition-stability view at regional level. At country level, our results are in favor of competition-fragility view that intense competition among banking institutions in a country will increase the chances of that country to be included among the countries have joint extreme negative return on a particular day. On the other hand, the emphasis on loan-making activities at regional level increase the probability of individual country to coexceed when other countries have joint occurrence of extreme low returns.

In Latin America, we find that increase in aggregate liquidity and/or banking system capitalization at regional and country level significantly reduce the probability of an individual country to coexceed with at least one another country in the region. The concentration in banking industry though significant at both regional and country level, but has opposite signs. We find that higher concentration at regional level increase the likelihood of an individual country to be part of the countries that have joint extreme negative returns, but at the country level it reduces the likelihood in similar fashion as in Asia. Regarding diversification, we find that the increase in focus on traditional loan-making activities at country level has a significant positive effect on probability of an individual country to coexceed with others in the region. This result is different from the incidence of significant positive effect of the same variable, but at regional level in Asia.

<please insert table 4.10 here>

Beside factors within region, we also explore whether the cross-regional contagion effect can influence the likelihood of an individual country to coexceed. To achieve this task we introduce cross-regional contagion effect through binary variable whose value is 1 when two or more countries coexceed in the triggering region. Table 4.10 reports cross-regional contagion effect from triggering region in Asia and Latin America. We find that contagion effects in Asia are statistically significant at 1 percent from all triggering regions, but the economic significance is minimal in case of the United States. However, the contagion effect from the US is statistically insignificant when we include the contagion variables from all regions simultaneously in model

4. Similarly, in lower panel, we find that contagion effects in Latin America from all triggering regions are also significant at 1 percent level. Moreover, the contagion effect from all triggering regions remain significant at 1 percent level even when they are included simultaneously in model 4.

4.6 ROBUSTNESS

In this section we analyze the robustness of earlier analysis using alternative model specifications. First, we check robustness of our dependent variable using alternative measures for regional banking system fragility. In our initial analysis we define banking system fragility through the number of coexceedances in the region on a particular day. We have five categories that are 0, 1, 2, 3 and 4 or more; which represents the number of countries having joint extreme negative returns on that day. Higher number of coexceedances is thus referred to more fragile regional banking system. Due to the nature of our dependent variable we use multinomial logistics model. Now let assume that we are not interested in actual number of coexceedances on a particular day; rather we are interested in the question whether regional banking system is stable or fragile under given values of common factors and banking system characteristics. We construct a binary variable with value 1 when 2 or more countries coexceed in the region (represents fragility of regional banking system) else 0 (represents stability in regional banking system). For this analysis we use probit model with the same set of independent variables. We find that all common variables and banking characteristics significantly affect the probability of banking system fragility in the region. We report estimation results in table 4.11, wherein it is evident that conditional stock market volatility, currency depreciation, and increase in interest rate level will increase the probability of regional banking system fragility in Asia and Latin America. Similarly, we find that the increase in aggregate liquidity and competition will reduce the probability of regional banking system fragility in both regions; whereas capitalization will diminish the probability of regional banking system fragility in Latin America only. Diversification in banking activities fails to affect the probability of banking system fragility in any region. We also investigate the cross-regional contagion and results are reported in table 4.12. Once again we find that both Asia and Latin America are affected significantly by cross-regional contagion from all other regions. The economic magnitude of cross-regional contagion effect from Europe is the highest, followed by the contagion effect from the US in both Asia and Latin America.

<please insert table 4.11 and table 4.12 here>

Second, we check robustness with respect to our measure of cross-regional contagion. In our previous analysis, we follow Bae, Karolyi and Stulz (2003) and use the number of coexceedances in triggering region as contagion indicator. But we have multiple countries from Asia and Latin America; whereas the US and Europe are treated as single entities. Resultantly, we have different cross-regional contagion variable for emerging market regions (Asia and Latin America have variable with values from 0 to 4) and developed regions (the US and Europe have binary variable). In order to be consistent among all cross-regional contagion variable we construct a binary cross-regional contagion variable for Asia and Latin America, whose value is 1 when 2 or more countries coexceed, else 0. We use this indicator variable to re-investigate the cross-regional contagion that is triggered from Asia or Latin America in multinomial logistics model and results are reported as '2 or more coexceedances' in table 4.13. We find that cross-regional contagion that is triggered from Asia or Latin America is significant for all number of coexceedance in the host region. In terms of economic magnitude we find that cross-regional contagion has the highest effect on 2 coexceedances in host region. Alternatively, we construct a binary variable for Asia and Latin America directly from regional banking indices through Datastream (a similar approach is used for the construction of binary variable for the US and Europe). This variable has value 1 when daily total market return lies below 5th percentile on a particular day. The cross-regional contagion through this binary variable is reported as 'Regional Index' in table 4.13. We find that cross-regional contagion effect is robust to all specifications of indicator variables.

<please insert table 4.13 here>

4.7 CONCLUSION

In this chapter we investigate regional banking system fragility and explore contagion within and across regions. We define regional banking system fragility through the number of joint occurrences of extreme negative returns in banking system indices. We use common macro variables and banking system characteristics as explanatory variables of regional banking system fragility. We find that an increase in regional conditional stock market volatility, a fall in currencies and a rise in interest rates significantly increase banking system fragility in Asia and Latin America. In terms of banking system characteristics, we find that higher regional banking

system liquidity is the most important factor to reduce the probability of coexceedances in all regions, but the effect decreases in magnitude for the higher number of coexceedances. The banking system capital also plays significant role in reducing the probability of coexceedances in the region; however, we find that the effect of capitalization is more significant in Latin America as compared to Asia. Regarding the impact of banking competition, we find that an increase in competition significantly reduces the probability of joint occurrences of extreme negative returns in both regions. Furthermore, we find that a focus on traditional loan making activities though increase the likelihood of a single country in the bottom tail, has no significant impact on joint occurrences of extreme negative returns in multiple countries in the region.

We also explore contagion within and across regions. We define contagion within region as the portion of regional banking system fragility (joint occurrences of extreme negative returns) that is not explained by the region's banking system characteristics and common variables. We find similar evidence of contagion within region as reported in Bae, Karolyi and Stulz (2003) that contagion differs across regions and it is stronger in Latin America than in Asia. Moreover, we find that the pseudo-R2 is substantially lower in the emerging market regions (Asia and Latin America); therefore, we argue that contagion within region is higher in emerging market regions, in general, compared to developed regions. For cross-regional contagion, we find that, in Asia, the effect is significant at the 1 percent level for all number of coexceedances when it is triggered from the US, whereas contagion triggered from Latin America and Europe have significant effect on 2 or more coexceedances. In terms of economic magnitude, in Asia, the cross-regional contagion effect that is triggered from the US is highest. In Latin America, the cross-regional contagion effect from all regions is significant for any number of coexceedances at 1 percent level. However, the economic significance is low in the case of contagion from Asia compared to the US and Europe. In short, we find that cross-regional contagion is significant but differs in magnitude across regions. The cross-contagion effects of Europe and the US on Asia and Latin America are significantly higher compared to the effect of Asia and Latin America among themselves.

We also explore whether banking system characteristics in emerging market regions have any influence on the cross-regional contagion effect. We find that aggregate liquidity significantly reduces cross-regional contagion from Latin America in Asia and from the US in Latin America.

Banking concentration significantly reduces the contagion effect from Europe in Asia, but it increases contagion-effect from the US in Latin America. Asset diversity reduces cross-regional contagion effect from Europe in Asia only. Capitalization works only in Latin America in reducing contagion effect from the US.

Lastly, we investigate what banking system characteristics and/or common macro variables influence the likelihood of an individual country to coexceed when other countries in the region have joint occurrences of extreme negative returns. We find that aggregate liquidity and banking system capitalization significantly reduces the probability of that country's coexceedances in both Asia and Latin America.

A natural conclusion of this research for policy makers is that the policy coordination at the regional level is needed to ensure financial stability in the global framework of multinational financial conglomerates. Banks are the most fragile institutions in the financial industry and their instability is most costly because of the interlinkages with other banks and the real sector of the region. Therefore, central banks that are responsible for monetary and financial stability to ensure sustainable economic growth, should cautiously evaluate economic and banking developments in the whole region next to their own country's economic and financial environment.

Table 4.1: Summary Statistics of Daily Returns on Banking Indices

	CHN	KOR	PHL	TWN	INA	IND	MAL	PAK	SRI	THA	ARG	BRA	CHI	COL	MEX	PER	VEN	USA	EUR
No. of banks	14	17	15	11	40	27	11	28	14	11	7	26	7	11	8	13	18	38	172
Mean (%)	0.089	0.028	0.019	0.020	0.072	0.038	0.039	0.073	0.024	0.000	0.034	0.081	0.050	0.047	0.095	0.065	0.085	0.041	0.035
Std. Dev. (%)	2.379	2.787	1.430	2.033	2.282	3.322	1.834	2.249	1.590	2.566	2.371	1.914	1.188	1.233	2.342	1.400	1.615	1.826	1.389
Median (%)	0.004	0.000	0.006	0.000	0.006	0.005	0.013	0.015	0.008	0.000	0.007	0.013	0.015	0.021	0.003	0.022	0.018	0.014	0.068
Minimum (%)	-17.065	-14.899	-11.006	-9.863	-13.955	-20.202	-20.321	-11.951	-14.882	-19.437	-27.682	-27.730	-21.266	-9.926	-13.832	-11.850	-17.525	-17.583	-10.813
Maximum (%)	25.428	17.629	16.300	13.869	14.571	27.308	32.269	16.602	28.180	20.238	33.333	42.566	10.830	11.737	28.538	14.020	17.917	19.357	16.065

Correlations	CHN	KOR	PHL	TWN	INA	IND	MAL	PAK	SRI	THA	ARG	BRA	CHI	COL	MEX	PER	VEN	USA	EUR
CHN	1.00										0.06	0.03	0.01	0.04	0.03	0.01	-0.01	0.09	0.07
KOR	0.09	1.00									0.07	0.14	0.07	0.04	0.10	0.06	0.03	0.21	0.19
PHL	0.07	0.14	1.00								0.14	0.19	0.12	0.11	0.15	0.07	0.03	0.25	0.24
TWN	0.06	0.18	0.16	1.00							0.06	0.09	0.07	0.06	0.08	0.04	0.02	0.16	0.12
INA	0.08	0.14	0.11	0.12	1.00						0.06	0.12	0.08	0.09	0.08	0.01	0.00	0.14	0.09
IND	0.03	0.08	0.19	0.09	0.09	1.00					0.11	0.08	0.10	0.05	0.10	0.05	0.02	0.12	0.11
MAL	0.05	0.15	0.17	0.13	0.11	0.16	1.00				0.09	0.05	0.07	0.05	0.09	0.04	0.03	0.17	0.11
PAK	0.02	0.03	0.05	0.06	0.08	0.03	0.07	1.00			0.03	0.04	0.04	0.05	0.01	0.02	0.00	0.04	0.04
SRI	0.01	0.00	0.03	0.03	0.01	0.01	0.03	0.06	1.00		0.04	0.03	0.05	0.03	0.00	0.03	-0.01	0.05	0.05
THA	0.06	0.21	0.21	0.16	0.14	0.19	0.29	0.06	0.04	1.00	0.09	0.11	0.07	0.05	0.13	0.06	0.03	0.17	0.14
Asia					**0.10**									**0.06**				**0.14**	**0.12**
ARG	-0.02	0.05	0.09	0.05	0.03	0.04	0.07	0.02	0.02	0.11	1.00								
BRA	0.04	0.04	0.07	0.09	0.13	0.05	0.07	0.02	0.01	0.11	0.28	1.00							
CHI	0.02	0.11	0.09	0.08	0.10	0.07	0.08	0.02	0.04	0.10	0.14	0.23	1.00						
COL	0.05	0.05	0.08	0.06	0.07	0.06	0.05	0.04	0.04	0.08	0.09	0.13	0.13	1.00					
MEX	0.00	0.08	0.07	0.05	0.06	0.07	0.07	0.04	-0.01	0.10	0.31	0.28	0.15	0.08	1.00				
PER	0.06	0.04	0.08	0.07	0.07	0.06	0.04	0.00	0.02	0.07	0.15	0.14	0.12	0.08	0.13	1.00			
VEN	0.01	0.01	0.02	-0.01	0.00	0.02	0.02	-0.01	-0.01	0.05	0.03	0.05	0.02	0.03	0.03	0.03	1.00		
Latin America					**0.05**									**0.13**					
United States	-0.01	0.03	0.01	0.05	0.09	0.04	0.02	0.00	-0.01	0.07	0.25	0.31	0.16	0.11	0.27	0.06	0.03	1.00	
					0.03									**0.17**					
Europe	0.07	0.16	0.18	0.14	0.18	0.13	0.16	0.04	0.04	0.23	0.23	0.31	0.25	0.21	0.23	0.14	0.06	0.39	1.00
					0.13									**0.20**					

We report data from 10 Asian countries, 7 Latin American countries, the USA and European block. Asian countries include China (CHN), Korea (KOR), Philippines (PHL), Taiwan (TWN), India (INA), Indonesia (IND), Malaysia (MAL), Pakistan (PAK), Sri Lanka (SRI) and Thailand (THA). Whereas, Latin American countries include Argentina (ARG), Brazil (BRA), Chile (CHI), Colombia (COL), Mexico (MEX), Peru (PER) and Venezuela (VEN).We report number of banks from each country/region. Summary statistics include mean, standard deviation, median, minimum, maximum and correlations of daily banking index returns as reported in Datastream during the sample period (July 01, 1994 to December 31, 2008). The correlations in upper right matrix are adjusted for 1 day lag in western hemisphere; therefore, these numbers are correlation coefficients between daily returns of Asian countries in day *t* and those of Latin America, the United States and Europe in day *t-1*. Averages of correlations that are presented in **bold,** represents regional correlations of block above and adjacent to the statistics.

Table 4.2(a): Coexceedances in Banking Indices

	Number of Negative Coexceedances						Number of Positive Coexceedances					
	Mean return when >=4	>=4	3	2	1	0	0	1	2	3	>=4	Mean return when >=4
CHN	-4.69%	19	17	41	113	2497	2451	121	45	17	7	7.32%
KOR	-7.40%	28	34	54	74	2497	2451	78	61	27	24	7.42%
PHL	-4.16%	33	31	54	72	2497	2451	89	57	21	23	3.35%
TWN	-4.66%	30	26	42	92	2497	2451	109	47	16	18	5.52%
INA	-5.74%	25	22	53	90	2497	2451	97	56	23	14	6.83%
IND	-7.77%	29	22	52	87	2497	2451	84	57	26	23	10.07%
MAL	-4.21%	35	41	55	59	2497	2451	74	59	28	29	5.29%
PAK	-7.18%	11	18	38	123	2497	2451	100	58	20	12	5.43%
SRI	-3.87%	12	8	43	127	2497	2451	115	55	14	6	3.70%
THA	-6.06%	38	33	48	71	2497	2451	76	57	27	30	8.58%
Total	-5.57%	55	84	240	908	2497	2451	943	276	73	41	6.35%
		0										
ARG	-7.07%	33	29	41	87	2832	2744	102	55	16	17	8.39%
BRA	-4.91%	33	30	48	79	2832	2744	97	56	19	18	6.25%
CHI	-3.34%	25	17	39	109	2832	2744	103	55	16	16	4.30%
COL	-4.00%	19	17	41	113	2832	2744	136	39	7	8	4.03%
MEX	-6.28%	32	23	44	91	2832	2744	121	38	17	14	6.87%
PER	-3.66%	24	15	39	112	2832	2744	122	41	13	14	3.74%
VEN	-4.67%	11	13	38	128	2832	2744	148	34	5	3	3.94%
Total	-4.85%	40	48	145	719	2832	2744	829	159	31	21	5.36%

The dataset consist of 3784 daily returns from each country during the sample period (July 01, 1994 to December 31, 2008). When daily returns are sorted in ascending order, the lowest five percent data points correspond to Negative coexceedances and highest five percent are labeled as Positive coexceedances. Coexceedance represents the joint occurrences of coexceedances across countries by day. A 0 coexceedance means no country exceed on that day in the whole region. Similarly, any number (1, 2, …n; where n is the total number of countries in the region) of coexceedances can be observed on a given day. We report negative (left panel) and positive (right panel) coexceedances separately. For example, in Asia, there are 2497 days when no country has negative coexceedance but it is possible that a number of countries have positive coexceedances during those days. We have stratified the number of coexceedances into four groups (1, 2, 3, and >=4). At the bottom of each block, the total number of days is reported for each number of coexceedance. For example, out of 3784 trading days, we have observed 908 days when only 1 country negatively exceeds in Asia. Similarly, we find 240 days when 2 countries coexceed (negative) and 55 days when 4 or more countries coexceed in Asia. Within each region, we also mention how often a particular country exceeds. For instance, we find that China is the only country on 113 days out of 908 days when 1 country has lowest extreme return. Similarly, there are 19 days out of 55 days when China is among those 4 or more countries that have joint occurrences of negative coexceedances. The first (last) column gives mean returns when 4 or more countries have negative (positive) coexceedance. The bottom row 'Total' provide mean return irrespective of which countries are included, whereas numbers associated with country are mean return of that particular country when it is among those 4 or more countries. For example, in Asia, the average daily return of all countries in those 55 days is -5.57 percent. Whereas, the average daily return for China in those 19 out of 55 days is -4.69 percent.

Table 4.2(b): Monte Carlo Evidence on Coexceedances in Banking Indices

	Number of Negative (co-)exceedances					Number of Positive (co-)exceedances				
	>=4	3	2	1	0	0	1	2	3	>=4
Panel A: Asia										
Actual	55	84	240	908	2497	2451	943	276	73	41
Multivariate Normality										0
Simulated Mean	19.38	70.31	289.64	1020.09	2385.06	2385.26	1019.65	289.81	70.52	18.76
Standard Deviation	5.62	7.25	14.10	26.01	15.69	15.27	25.04	13.27	7.35	5.48
5th Quantile	10	59	267	980	2358	2361	979	268	59	10
95th Quantile	31	83	313	1067	2410	2411	1062	313	83	31
p-value	0.000	0.000	0.000	0.000	0.405	0.245	0.000	0.000	0.000	0.000
Panel B: Latin America										
Actual	40	48	145	719	2832	2744	829	159	31	21
Multivariate Normality										
Simulated Mean	6.68	35.57	181.39	825.88	2734.48	2734.42	826.27	180.94	35.54	6.83
Standard Deviation	3.48	5.41	11.18	21.51	12.41	12.54	21.28	10.88	5.45	3.56
5th Quantile	2	27	162	790	2714	2714	791	164	27	2
95th Quantile	13	44	200	862	2755	2756	861	200	45	13
p-value	0.000	0.000	0.000	0.000	0.397	0.973	0.000	0.000	0.000	0.000

Table 4.2(b) presents Monte Carlo evidence on the distribution of coexceedances in banking indices using covariance matrix from the observed 3784 daily observation and assuming normality conditions.

Table 4.2(c): Frequency distribution of the number of excess coexceedance in banking relative to total market indices

Excess Coexceedances	Frequency
ASIA	
-5	1
-4	6
-3	23
-2	85
-1	405
0	2669
1	525
2	62
3	8
LATIN AMERICA	
-3	21
-2	70
-1	368
0	2801
1	481
2	39
3	4

Excess exceedances in baking indices are measured by subtracting the number of coexceedances in total market indices from the number of coexceedances in banking system indices for each daily observation in both Asia and Latin America. Each frequency value refers to the number of days for respective excess coexceedance in total sample of 3784 trading days

Table 4.3: Summary Statistics of Common Macro Variables

Common Factors	Conditional Volatility		Exchange Rate Changes		Interest Rate Level	
%	Mean	Std Dev.	Mean	Std Dev.	Mean	Std Dev.
CHN	29.289	13.844	-0.006	0.056	4.345	3.093
KOR	33.741	18.996	0.016	0.959	7.619	3.678
PHL	21.974	6.977	0.017	0.561	10.370	3.820
TWN	24.230	6.969	0.006	0.304	3.938	2.075
INA	23.034	8.617	0.012	0.283	8.392	2.630
IND	26.331	11.182	0.011	0.876	13.361	7.504
MAL	18.157	12.171	0.011	0.659	4.785	2.225
PAK	26.635	9.733	0.026	0.436	9.600	3.909
SRI	17.617	20.879	0.022	0.257	13.319	3.721
THA	27.627	9.358	0.012	0.606	9.191	3.145
Asia	**21.188**	**9.949**	**0.013**	**0.226**	**8.492**	**2.838**
ARG	24.744	8.816	0.043	1.667	21.488	22.034
BRA	24.047	10.137	0.032	0.935	1.072	0.770
CHI	12.544	4.960	0.015	0.807	0.498	0.210
COL	14.418	7.278	0.028	0.568	16.399	10.325
MEX	19.380	7.427	0.042	0.974	16.485	10.714
PER	18.431	6.591	0.010	0.337	12.793	2.934
VEN	38.986	19.974	0.080	1.869	17.529	9.145
Latin America	**23.389**	**10.842**	**0.036**	**0.458**	**12.140**	**4.863**

Table 4.3 reports mean and standard deviation of macro variables during the sample period for each country from July 01, 1994 to December 31, 2010. Regional variables are obtained by simple average of individual country.

Table 4.4: Summary Statistics of Banking Characteristics

Banking System	Narrow Liquidity		Broader Liquidity		Asset Diversity		Loan-Ratio		Concentration		Capitalization	
Characteristics	Mean	Std Dev.	Mean	Std Dev.	Mean	Std Dev.	Mean	Std Dev.	Mean	Std Dev.	Mean	Std Dev.
CHN	0.021	0.022	0.155	0.050	0.848	0.124	0.538	0.092	0.800	0.083	0.035	0.012
KOR	0.054	0.010	0.309	0.039	0.832	0.068	0.584	0.034	0.464	0.064	0.051	0.011
PHL	0.037	0.015	0.279	0.099	0.838	0.093	0.432	0.065	0.597	0.049	0.118	0.011
TWN	0.022	0.005	0.150	0.058	0.923	0.051	0.492	0.049	0.490	0.110	0.077	0.010
INA	0.125	0.019	0.306	0.038	0.858	0.074	0.480	0.080	0.495	0.062	0.065	0.006
IND	0.050	0.022	0.317	0.157	0.785	0.161	0.536	0.132	0.693	0.096	0.079	0.092
MAL	0.022	0.014	0.288	0.020	0.798	0.071	0.601	0.035	0.442	0.063	0.088	0.015
PAK	0.116	0.025	0.341	0.064	0.855	0.062	0.475	0.077	0.789	0.138	0.062	0.040
SRI	0.017	0.006	0.395	0.045	0.913	0.057	0.532	0.041	0.825	0.118	0.077	0.025
THA	0.024	0.004	0.261	0.041	0.727	0.099	0.637	0.050	0.603	0.065	0.065	0.022
Asia	**0.028**	**0.009**	**0.213**	**0.037**	**0.907**	**0.091**	**0.540**	**0.052**	**0.625**	**0.043**	**0.053**	**0.003**
ARG	0.025	0.010	0.190	0.060	0.748	0.153	0.469	0.147	0.593	0.075	0.111	0.013
BRA	0.015	0.004	0.398	0.067	0.710	0.064	0.355	0.032	0.545	0.073	0.078	0.007
CHI	0.058	0.016	0.307	0.057	0.746	0.105	0.617	0.074	0.746	0.076	0.047	0.013
COL	0.033	0.013	0.303	0.134	0.780	0.205	0.576	0.131	0.571	0.085	0.201	0.046
MEX	0.039	0.023	0.197	0.075	0.739	0.162	0.629	0.083	0.648	0.133	0.087	0.024
PER	0.080	0.114	0.240	0.096	0.892	0.091	0.472	0.066	0.807	0.047	0.073	0.014
VEN	0.106	0.030	0.362	0.082	0.653	0.157	0.362	0.134	0.758	0.085	0.158	0.060
Latin America	**0.029**	**0.005**	**0.324**	**0.056**	**0.888**	**0.062**	**0.444**	**0.031**	**0.593**	**0.053**	**0.087**	**0.009**

The table report mean and standard deviation of banking system characteristics during the sample period for each country from July 01, 1994 to December 31, 2010. Regional variables are obtained by weighted-average of individual country using total assets of banking system as weights.

Table 4.5: Common Macro Factors and Regional Banking System Fragility

Negative Coexceedances		No. of Coex	Relative Freq	Model 1 Coeff	Model 1 Chg Prob	Model 2 Coeff	Model 2 Chg Prob	No. of Coex	Relative Freq	Model 1 Coeff	Model 1 Chg Prob	Model 2 Coeff	Model 2 Chg Prob
		ASIA						LATIN AMERICA					
Base Case	0	2497	0.660					2832	0.748				
Constant	1	908	0.240	-1.755 [a]		-2.422 [a]		719	0.190	-1.900 [a]		-2.350 [a]	
	2	240	0.063	-3.945 [a]		-5.758 [a]		145	0.038	-4.551 [a]		-5.472 [a]	
	3	84	0.022	-5.399 [a]		-6.943 [a]		48	0.013	-6.185 [a]		-6.962 [a]	
	>=4	55	0.015	-6.712 [a]		-8.594 [a]		40	0.011	-7.168 [a]		-8.304 [a]	
Conditional Volatility	1			0.034 [a]	0.005	0.033 [a]	0.005			0.020 [a]	0.003	0.018 [a]	0.002
	2			0.071 [a]	0.003	0.066 [a]	0.003			0.057 [a]	0.002	0.054 [a]	0.001
	3			0.087 [a]	0.001	0.077 [a]	0.001			0.072 [a]	0.001	0.070 [a]	0.001
	>=4			0.114 [a]	0.001	0.104 [a]	0.001			0.090 [a]	0.000	0.089 [a]	0.000
Exchange Rate Changes	1					0.602 [a]	0.080					0.388 [a]	0.054
	2					1.420 [a]	0.061					0.533 [a]	0.013
	3					2.169 [a]	0.032					0.593 [a]	0.004
	>=4					2.363 [a]	0.015					0.788 [a]	0.003
Interate Rate Level	1					0.084 [a]	0.011					0.040 [a]	0.005
	2					0.217 [a]	0.010					0.075 [a]	0.002
	3					0.192 [a]	0.003					0.064 [b]	0.000
	>=4					0.220 [a]	0.001					0.079 [b]	0.000
Log-Likelihood				-3,180.36		-3,107.02				-2,461.59		-2,423.92	
Pseudo-R^2				0.0437		0.0658				0.0408		0.0555	

We use the number of coexceedances of daily returns as dependent variable in multinomial logistics model. We define five categories for number of coexceedances I.e. 0, 1, 2, 3, and >=4 on a given day. a, b, and c denotes significance level at 1%, 5% and 10% respectively.

Table 4.6(a): Banking System Characteristics and Regional Banking System Fragility

		Model 1		Model 1A		Model 2		Model 2A		Model 2B		Model 3		Model 4		Model 4A	
Negative Coexceedances		**Coeff**	**Chg Prob**	**Coeff**	**Chg Prob**	**Coeff**	**Chg Prob**	**Coeff**	**Chg Prob**	**Coeff**	**Chg Prob**	**Coeff**	**Chg Prob**	**Coeff**	**Chg Prob**	**Coeff**	**Chg Prob**
ASIA																	
Narrow Liquidity	1	-14.590 [c]	-2.011														
	2	-31.030 [b]	-1.305														
	3	-36.470 [c]	-0.502														
	>=4	-83.240 [a]	-0.520														
Broader Liquidity	1			-13.740 [a]	-2.238												
	2			-20.270 [a]	-0.800												
	3			-10.030 [c]	-0.093												
	>=4			0.760	0.040												
Asset Diversity	1					-3.453 [a]	-0.527										
	2					-7.334 [a]	-0.314										
	3					-3.256	-0.033										
	>=4					-3.011	-0.013										
Loan Ratio	1							5.992 [a]	1.105	8.358 [a]	1.556						
	2							1.581	0.007	1.504	-0.023						
	3							1.568	0.002	-1.670	-0.061						
	>=4							-16.780	-0.134	-18.330	-0.150						
Loan Ratio Heterogeneity	1									10.371	1.973						
	2									-0.209	-0.130						
	3									-13.171	-0.261						
	>=4									-6.609	-0.065						
Concentration	1											5.773 [a]	0.966				
	2											6.403 [a]	0.238				
	3											4.206	0.041				
	>=4											-1.850	-0.028				
Capitalization	1													9.014	1.327	-8.451	-1.277
	2													14.390	0.570	-25.37	-1.162
	3													46.590	0.701	32.06	0.578
	>=4													-17.290	-0.155	-47.90	-0.330
Capitalization Heterogeneity	1															10.200 [a]	1.653
	2															14.010 [a]	0.555
	3															7.064	0.059
	>=4															12.55	0.067
Constant		YES		YES		YES		YES		YES		YES		YES		YES	
Conditional Volatility		YES		YES		YES		YES		YES		YES		YES		YES	
Exchange Rate Changes		YES		YES		YES		YES		YES		YES		YES		YES	
Interest Rate Level		YES		YES		YES		YES		YES		YES		YES		YES	
Log-Likelihood		-3076.30		-3051.01		-3061.34		-3074.76		-3073.23		-3063.86		-3082.34		-3068.05	
Pseudo-R^2		0.0809		0.0826		0.0795		0.0755		0.0759		0.0788		0.0732		0.08	

We use the number of coexceedances of daily return as dependent variable in multinomial logistic model. We define five categories for number of coexceedances i.e. 0, 1, 2, 3 and >=4 on a given day. In addition to conditional volatility, exchange rate changes rate and average interest rate level, we also control variables banking system characteristics. For the United States and Europe we use logit regression model. [a, b] and [c] denotes significance levels at 1%, 5% and 10% respectively.

Table 4.6(b): Banking System Characteristics and Regional Banking System Fragility

		Model 1		Model 1A		Model 2		Model 2A		Model 2B		Model 3		Model 4		Model 4A	
Negative Coexceedances		**Coeff**	**Chg Prob**	**Coeff**	**Chg Prob**	**Coeff**	**Chg Prob**	**Coeff**	**Chg Prob**	**Coeff**	**Chg Prob**	**Coeff**	**Chg Prob**	**Coeff**	**Chg Prob**	**Coeff**	**Chg Prob**
LATIN AMERICA																	
Narrow Liquidity	1	-51.980 [a]	-7.042														
	2	-100.500 [a]	-2.369														
	3	-99.980 [b]	-0.663														
	>=4	-212.600 [a]	-0.603														
Broader Liquidity	1			-5.113 [a]	-0.724												
	2			-6.945 [b]	-0.164												
	3			-1.107	0.001												
	>=4			-8.739	-0.030												
Asset Diversity	1					2.669 [a]	0.383										
	2					2.788	0.063										
	3					0.986	0.003										
	>=4					2.089	0.006										
Loan Ratio	1							5.338 [a]	0.766	4.206 [b]	0.615						
	2							5.576	0.126	3.875	0.086						
	3							1.972	0.006	-1.279	-0.017						
	>=4							4.177	0.012	-3.270	-0.015						
Country Heterogeneity	1									6.250 [a]	0.872						
	2									6.944 [c]	0.155						
	3									11.260	0.078						
	>=4									18.010 [b]	0.062						
Concentration	1											5.822 [a]	0.820				
	2											7.746 [a]	0.181				
	3											3.350	0.016				
	>=4											11.150 [c]	0.038				
Capitalization	1													-32.980 [a]	-4.587	-35.010 [a]	-4.874
	2													-50.560 [a]	-1.188	-52.080 [a]	-1.217
	3													-34.100	-0.209	-34.310	-0.207
	>=4													-71.670 [b]	-0.239	-77.100 [b]	-0.255
Capitalization Heterogeneity	1															4.344	0.625
	2															3.224	0.064
	3															0.478	-0.004
	>=4															12.35	0.042
Constant		YES		YES		YES		YES		YES		YES		YES		YES	
Conditional Volatility		YES		YES		YES		YES		YES		YES		YES		YES	
Exchange Rate Changes		YES		YES		YES		YES		YES		YES		YES		YES	
Interest Rate Level		YES		YES		YES		YES		YES		YES		YES		YES	
Log-Likelihood		-2396.92		-2414.88		-2418.94		-2418.94		-2410.26		-2409.43		-2406.89		-2405.21	
Pseudo-R^2		0.07		0.0590		0.0574		0.0574		0.0608		0.0611		0.0621		0.06	

We use the number of coexceedances of daily return as dependent variable in multinomial logistic model. We define five categories for number of coexceedances i.e. 0, 1, 2, 3 and >=4 on a given day. In addition to conditional volatility, exchange rate changes rate and average interest rate level, we also control variables banking system characteristics. For the United States and Europe we use logit regression model. [a, b] and [c] denotes significance levels at 1%, 5% and 10% respectively.

Table 4.7: Cross-Border Contagion Effect and Regional Banking System Fragility

Contagion from Other Regions		Cross-Border Contagion to ASIA							
		Model 1		Model 2		Model 3		Model 4	
		Coeff	Chg Prob	Coeff	Chg Prob	Coeff	Chg Prob	Coeff	Chg Prob
Constant		YES		YES		YES		YES	
Control for Common Factors		YES		YES		YES		YES	
Control for Banking Characteristics		YES		YES		YES		YES	
Negative Coex. In Latin America	1	0.091	0.011					0.057	0.007
	2	0.248 [a]	0.010					0.149	0.006
	3	0.442 [a]	0.006					0.360 [a]	0.005
	>=4	0.787 [a]	0.005					0.624 [a]	0.003
Log-Likelihood		-3016.27							
Pseudo-R^2		0.0931							
Negative Coex. In USA	1			0.721 [a]	0.090			0.694 [a]	0.106
	2			1.418 [a]	0.082			1.234 [a]	0.068
	3			1.378 [a]	0.025			0.979 [a]	0.014
	>=4			2.394 [a]	0.032			1.347 [a]	0.007
Log-Likelihood				-3007.00					
Pseudo-R^2				0.0959					
Negative Coex. In Europe	1					0.196	-0.005	0.068	-0.014
	2					1.019 [a]	0.058	0.758 [a]	0.041
	3					1.253 [a]	0.027	1.010 [a]	0.021
	>=4					2.844 [a]	0.055	2.443 [a]	0.035
Log-Likelihood						-3002.98		-2970.46	
Pseudo-R^2						0.0971		0.1073	
Contagion from Other Regions		**Cross-Border Contagion to LATIN AMERICA**							
Constant		YES		YES		YES		YES	
Control for Common Factors		YES		YES		YES		YES	
Control for Banking Characteristics		YES		YES		YES		YES	
Negative Coex. In Asia	1	0.192 [a]	0.025					0.183 [a]	0.025
	2	0.490 [a]	0.012					0.451 [a]	0.010
	3	0.645 [a]	0.004					0.553 [a]	0.003
	>=4	0.821 [a]	0.002					0.681 [a]	0.001
Log-Likelihood		-2366.57							
Pseudo-R^2		0.0778							
Negative Coex. In USA	1			0.629 [a]	0.072			0.549 [a]	0.070
	2			1.589 [a]	0.066			1.419 [a]	0.054
	3			2.071 [a]	0.030			1.812 [a]	0.020
	>=4			2.932 [a]	0.030			2.721 [a]	0.014
Log-Likelihood				-2364.43					
Pseudo-R^2				0.0787					
Negative Coex. In Europe	1					0.750 [a]	0.091	0.596 [a]	0.086
	2					1.601 [a]	0.063	1.104 [a]	0.034
	3					2.327 [a]	0.036	1.672 [a]	0.017
	>=4					3.304 [a]	0.035	2.411 [a]	0.010
Log-Likelihood						-2356.96			
Pseudo-R^2						0.0816			

[a, b, c] Denotes significance levels at the 1%, 5% and 10% repectively.

We use the number of coexceedances of daily return as dependent variable in multinomial logistic model. We define five categories for number of coexceedances i.e. 0, 1, 2, 3 and >=4 on a given day. In addition to common variables and banking characteristics as control variables, we include the number of coexceedances in other regions as contagion variables.

Table 4.8: Banking System Characteristics in Host Region and Cross-Regional Contagion

Characteristics in Host Region -->		Narrow Liquidity		Loan-Ratio		Concentration		Capitalization	
		Coeff	Std Err	Coeff	Std Err	Coeff	Std Err	Coeff	Std Err
Contagion from Other Regions				**Cross-Border Contagion to ASIA**					
Constant		YES		YES		YES		YES	
Control for Common Factors		YES		YES		YES		YES	
Control for Banking Characteristics		YES		YES		YES		YES	
Latin America	1	-26.330 [a]	(9.33)	-2.860	(2.45)	0.279	(1.50)	-56.530 [a]	(20.33)
	2	-10.120	(12.49)	3.043	(3.65)	2.780	(2.20)	-14.580	(29.28)
	3	-17.810	(17.36)	-1.508	(4.67)	-0.523	(2.71)	-39.520	(37.83)
	>=4	-38.160 [c]	(22.24)	4.856	(5.03)	0.731	(2.88)	-105.500 [a]	(39.33)
US	1	0.722	(36.83)	1.010	(6.63)	-2.764	(3.86)	41.810	(81.64)
	2	13.680	(45.72)	3.151	(8.52)	-3.668	(5.01)	26.700	(96.49)
	3	13.850	(70.80)	12.600	(11.95)	-0.642	(7.12)	10.340	(141.10)
	>=4	12.680	(78.05)	-30.640 [c]	(16.40)	-28.000 [a]	(9.26)	17.510	(140.40)
Europe	1	-14.430	(44.45)	-6.358	(7.19)	-6.545	(4.27)	-83.810	(80.11)
	2	-29.670 [b]	(13.49)	-4.141	(9.24)	-9.395 [c]	(5.44)	-82.050	(96.80)
	3	-84.330	(21.55)	-24.470 [c]	(14.04)	-19.420 [b]	(7.87)	53.400	(128.90)
	>=4	-12.630	(65.56)	-25.150 [c]	(14.59)	-25.370 [a]	(8.64)	64.900	(124.90)
Contagion from Other Regions				**Cross-Border Contagion to LATIN AMERICA**					
Constant		YES		YES		YES		YES	
Control for Common Factors		YES		YES		YES		YES	
Control for Banking Characteristics		YES		YES		YES		YES	
Asia	1	-14.260	(10.50)	-0.232	(2.06)	-0.707	(1.16)	-9.589	(6.36)
	2	-12.381	(17.03)	-3.025	(3.27)	-1.405	(1.74)	10.490	(10.35)
	3	-33.384	(25.71)	-3.840	(4.86)	-3.000	(2.51)	-16.260	(15.33)
	>=4	-30.053	(29.95)	-3.811	(5.34)	0.256	(2.72)	-9.224	(17.81)
US	1	-16.112	(47.37)	-1.864	(6.67)	-1.373	(4.38)	13.560	(30.75)
	2	-108.704 [c]	(65.45)	4.790	(9.45)	8.000	(5.97)	-87.940 [b]	(41.41)
	3	-183.109 [b]	(91.39)	22.200 [c]	(13.44)	19.230 [b]	(8.19)	-122.500 [b]	(55.85)
	>=4	-177.128 [c]	(103.60)	6.998	(14.85)	10.490	(8.38)	-105.700 [c]	(60.46)
Europe	1	-17.396	(41.92)	-5.113	(6.98)	-6.137	(4.64)	25.580	(26.95)
	2	-28.424	(56.24)	1.867	(9.68)	-0.528	(6.01)	-6.707	(36.82)
	3	-0.624	(77.45)	-14.760	(14.50)	-2.896	(8.05)	19.080	(49.61)
	>=4	-95.420	(99.41)	-25.220	(16.74)	-5.432	(8.76)	62.700	(60.35)

The interaction effects between cross-regional contagion and banking system characteristics in regional host are estimated by using an algorithm developed by King, Tomz and Wittenberg (2003) when including interaction terms. [a, b, c] Denotes significance levels at the 1%, 5% and 10% repectively.

Table 4.9: Individual Country Characteristics and Regional Banking System Fragility

Negative Coexceedances	Coeff	Chg Prob	Coeff	Chg Prob	Coeff	Chg Prob	Coeff	Chg Prob
ASIA								
Constant	-3.053 [a]		-3.709 [a]		-3.680 [a]		-3.212 [a]	
Narrow Liquidity	-0.626 [c]	-0.028						
Narrow Liquidity (Regional)	-8.430 [a]	-0.382						
Capitalization			-1.214 [b]	0.055				
Capitalization (Regional)			-6.807	0.307				
Loan Ratio					0.173	0.008		
Loan Ratio (Regional)					0.939 [c]	0.043		
Concentration							-0.576 [a]	-0.026
Concentration (Regional)							0.550	0.025
Cond. Volatility	YES		YES		YES		YES	
Cond. Volatility (Regional)	YES		YES		YES		YES	
Exchg Rate Chg	YES		YES		YES		YES	
Exchg Rate Chg (Regional)	YES		YES		YES		YES	
Interest Rate Level	YES		YES		YES		YES	
Interest Rate Level (Regional)	YES		YES		YES		YES	
Log-Likelihood	-3577.59		-3580.03		-3581.02		-3565.16	
Pseudo-R^2	0.1231		0.1234		0.1237		0.1270	
LATIN AMERICA								
Constant	-1.709 [a]		-1.449 [a]		-4.079 [a]		-4.412 [a]	
Narrow Liquidity	-3.086 [a]	-0.098						
Narrow Liquidity (Regional)	-38.390 [a]	-1.221						
Capitalization			-1.025 [b]	-0.035				
Capitalization (Regional)			-16.251 [a]	-0.553				
Loan Ratio					0.576 [a]	0.020		
Loan Ratio (Regional)					1.417	0.049		
Concentration							-0.299 [c]	-0.010
Concentration (Regional)							2.643 [a]	0.091
Cond. Volatility	YES		YES		YES		YES	
Cond. Volatility (Regional)	YES		YES		YES		YES	
Exchg Rate Chg	YES		YES		YES		YES	
Exchg Rate Chg (Regional)	YES		YES		YES		YES	
Interest Rate Level	YES		YES		YES		YES	
Interest Rate Level (Regional)	YES		YES		YES		YES	
Log-Likelihood	-2010.62		-2042.63		-2051.12		-2049.68	
Pseudo-R^2	0.1672		0.1544		0.1505		0.1512	

We use a binary dependent variable whose value is 1 when the country coexceeds with at least one more country in the region using probit model. We use previous set of independent variables but they are now observed at country level as well as regional level. [a, b, c] Denotes significance levels at the 1%, 5% and 10% repectively.

Table 4.10: Individual Country Characteristics and Cross-Regional Contagion

	CROSS-BORDER REGIONAL CONTAGION TO ASIA							
	Model 1		Model 2		Model 3		Model 4	
Negative Coexcedances	**Coeff**	**Chg Prob**	**Coeff**	**Chg Prob**	**Coeff**	**Chg Prob**	**Coeff**	**Chg Prob**
Constant	YES		YES		YES		YES	
Control for Common Factors	YES		YES		YES		YES	
Control for Banking Characteristics	YES		YES		YES		YES	
Neg. Coex. In Latin America	0.735 [a]	0.074					0.469 [a]	0.035
Neg. Coex. In the US			0.368 [a]	0.027			0.013	0.001
Neg. Coex. In Europe					0.834 [a]	0.084	0.751 [a]	0.070
Log-Likelihood	-3849.19		-3896.36		-3752.38		-3727.86	
Pseudo-R^2	0.0847		0.0735		0.1080		0.1140	
	CROSS-BORDER REGIONAL CONTAGION TO LATIN AMERICA							
	Model 1		Model 2		Model 3		Model 4	
Negative Coexcedances	**Coeff**	**Chg Prob**	**Coeff**	**Chg Prob**	**Coeff**	**Chg Prob**	**Coeff**	**Chg Prob**
Constant	YES		YES		YES		YES	
Control for Common Factors	YES		YES		YES		YES	
Control for Banking Characteristics	YES		YES		YES		YES	
Neg. Coex. In Asia	0.725 [a]	0.063					0.475 [a]	0.028
Neg. Coex. In the US			0.894 [a]	0.083			0.645 [a]	0.044
Neg. Coex. In Europe					0.994 [a]	0.097	0.732 [a]	0.054
Log-Likelihood	-2462.63		-2380.08		-2338.03		-2258.69	
Pseudo-R^2	0.0888		0.1194		0.1353		0.1642	

We use probit regression with common variables and banking characteristics as control variables. The contagion effect is measured by coefficient of a binary variable whose value is 1 when at least 2 countries in other region coexceed else 0. [a, b] and [c] denotes significance levels at 1%, 5% and 10% respectively.

Table 4.11: Common Factors and Banking System Characteristics using Alternative Definition of Regional Banking System

Dependent Variable is 1 when 2 or more coexceedances else 0	Model 1		Model 2		Model 3		Model 4	
	Coeff	Chg Prob	Coeff	Chg Prob	Coeff	Chg Prob	Coeff	Chg Prob
ASIA								
Constant	-2.708 [a]		-2.442 [a]		-3.808 [a]		-3.247 [a]	
Conditional Volatility	0.032 [a]	0.005	0.035 [a]	0.005	0.035 [a]	0.005	0.035 [a]	0.005
Exchange Rate Changes	0.892 [a]	0.131	0.845 [a]	0.125	0.851 [a]	0.124	0.844 [a]	0.124
Interest Rate Level	0.125 [a]	0.018	0.101 [a]	0.015	0.088 [a]	0.013	0.097 [a]	0.014
Narrow Liquidity	-16.190 [a]	-2.370						
Loan Ratio			-1.228	-0.181				
Concentration					1.443 [c]	0.210		
Capitalization							-5.200	-0.762
Log-Likelihood	-992.96		-996.24		-994.88		-996.54	
Pseudo-R^2	0.16		0.1509		0.1491		0.1516	
LATIN AMERICA								
Constant	-1.264 [a]		-3.588 [a]		-4.465 [a]		-0.791	
Conditional Volatility	0.032 [a]	0.003	0.033 [a]	0.003	0.035 [a]	0.003	0.033 [a]	0.003
Exchange Rate Changes	0.258 [a]	0.022	0.234 [a]	0.020	0.236 [a]	0.021	0.241 [a]	0.021
Interest Rate Level	0.007 [b]	0.001	0.026 [a]	0.002	0.012 [b]	0.001	0.006 [b]	0.001
Narrow Liquidity	-46.400 [a]	-3.867						
Loan Ratio			1.716	0.149				
Concentration					2.998 [a]	0.260		
Capitalization							-20.740 [a]	-1.775
Log-Likelihood	-632.41		-644.85		-641.48		-639.43	
Pseudo-R^2	0.1609		0.1449		0.1508		0.1529	

[a, b] and [c] denotes significance levels at 1%, 5% and 10% respectively.

Table 4.12: Cross-Regional Contagion using Alternative Definition of Regional Banking System Fragility

Dependent Variable is 1 when or more coexceedances else 0	Cross-Regional Contagion to ASIA							
	Model 1		Model 2		Model 3		Model 4	
	Coeff	Chg Prob	Coeff	Chg Prob	Coeff	Chg Prob	Coeff	Chg Prob
Constant	YES		YES		YES		YES	
Control for Common Factors	YES		YES		YES		YES	
Control for Banking Characteristics	YES		YES		YES		YES	
Negative Coex. In Latin America	0.633 [a]	0.130					0.482 [a]	0.114
Negative Coex. In USA			0.692 [a]	0.145			0.476 [a]	0.123
Negative Coex. In Europe					0.721 [a]	0.154	0.565 [a]	0.090
Log-Likelihood	-969.19		-965.29		-965.02		-943.04	
Pseudo-R^2	0.1841		0.1821		0.1819		0.2009	
Contagion from Other Regions	**Cross-Regional Contagion to LATIN AMERICA**							
Constant	YES		YES		YES		YES	
Control for Common Factors	YES		YES		YES		YES	
Control for Banking Characteristics	YES		YES		YES		YES	
Negative Coex. In Asia	0.563 [a]	0.067					0.473 [a]	0.048
Negative Coex. In USA			0.912 [a]	0.141			0.782 [a]	0.105
Negative Coex. In Europe					0.951 [a]	0.151	0.707 [a]	0.090
Log-Likelihood	-613.21		-602.00		-599.44		-571.84	
Pseudo-R^2	0.1897		0.2031		0.2029		0.2408	

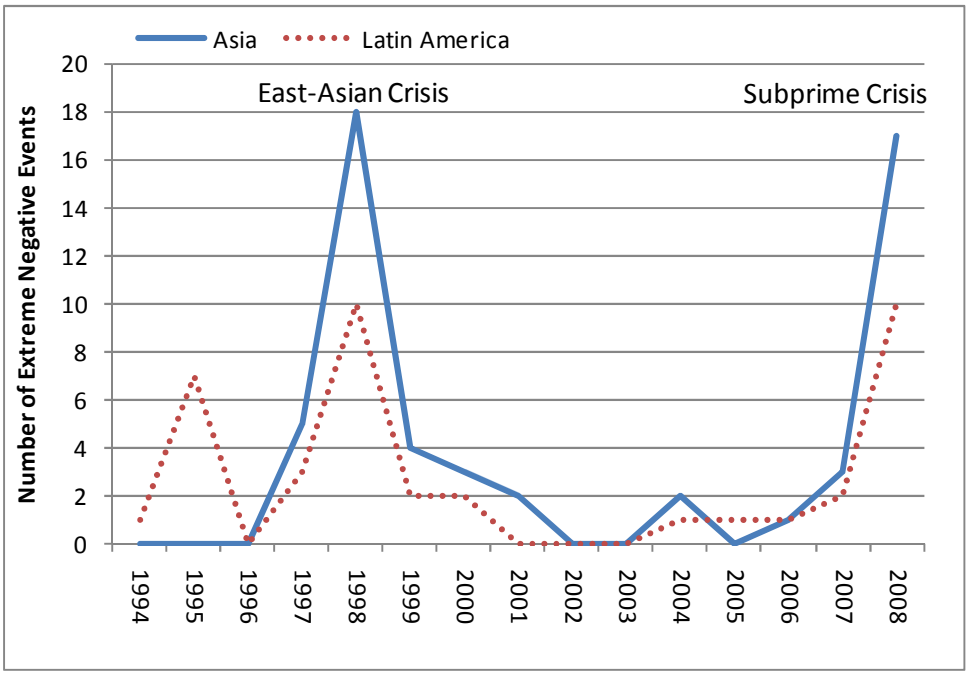
[a, b] and [c] denotes significance levels at 1%, 5% and 10% respectively.

Table 4.13: Cross-Regional Contagion using Alternative Definitions of Triggering Shock

Triggering Shock -->		2 or more Coexceedances				Regional Index			
		Asia		Latin America		Asia		Latin America	
Cross-Regional Contagion		**Coeff**	**Chg Prob**	**Coeff**	**Chg Prob**	**Coeff**	**Chg Prob**	**Coeff**	**Chg Prob**
Constant		YES		YES		YES		YES	
Control for Common Factors		YES		YES		YES		YES	
Control for Banking Characteristics		YES		YES		YES		YES	
ASIA	1			0.372 [c]	0.028			0.592 [a]	0.077
	2			1.110 [a]	0.064			1.094 [a]	0.057
	3			1.325 [a]	0.029			0.888 [b]	0.012
	>=4			2.398 [a]	0.039			2.430 [a]	0.039
Log-Likelihood				-3020.47				-3025.03	
Pseudo-R^2				0.0909				0.0929	
LATIN AMERICA	1	0.238 [a]	0.025			0.588 [a]	0.082		
	2	1.013 [a]	0.035			1.113 [a]	0.038		
	3	1.440 [a]	0.016			1.576 [a]	0.019		
	>=4	1.585 [a]	0.006			2.351 [a]	0.013		
Log-Likelihood		-2367.76				-2365.37			
Pseudo-R^2		0.0819				0.0828			

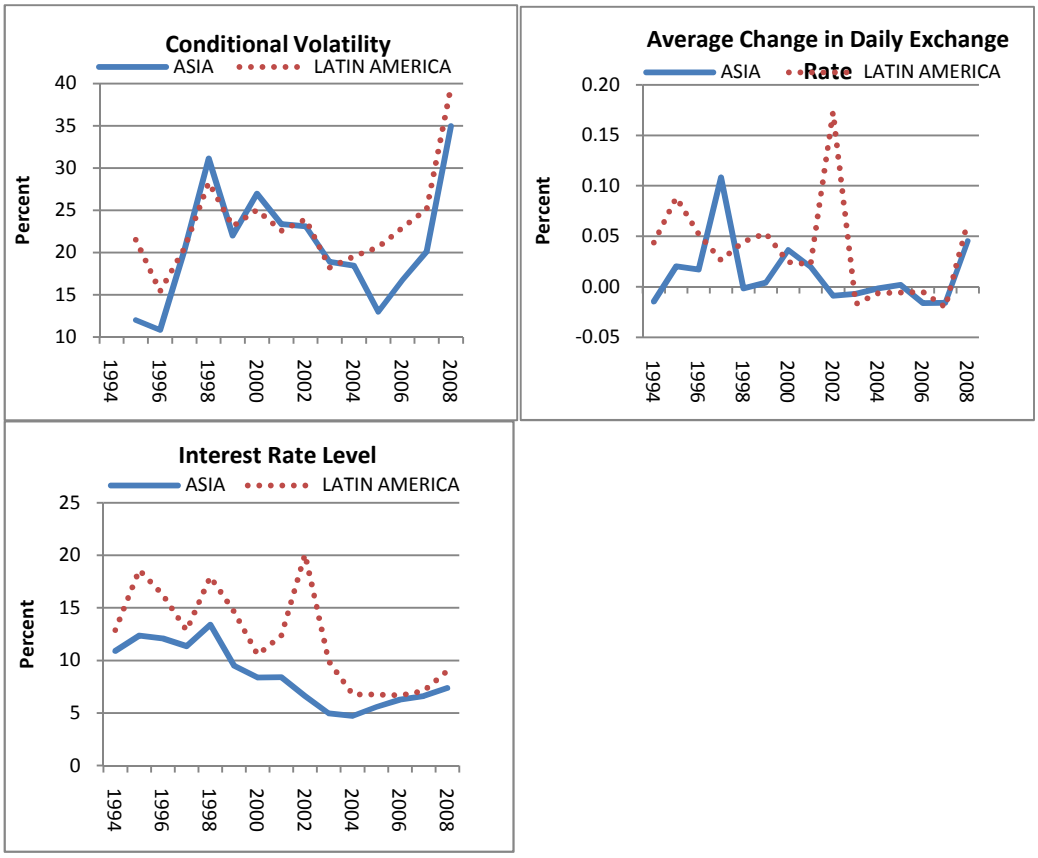
[a, b] and [c] denotes significance levels at 1%, 5% and 10% respectively.

Figure 4.1: Clustering of Negative Extreme Events in Banking Indices



We define negative extreme event when 4 or more countries have lowest 5 percent returns. Out of total 3784 trading days, we observe 55 and 40 negative extreme events in Asia and Latin America respectively. On y-axis, we measure the number of extreme events during each year in our sample period.

Figure 4.2: Trend in Common Variables



Daily observations are averaged to get annual trend

Figure 4.3: Trend in Banking Characteristics

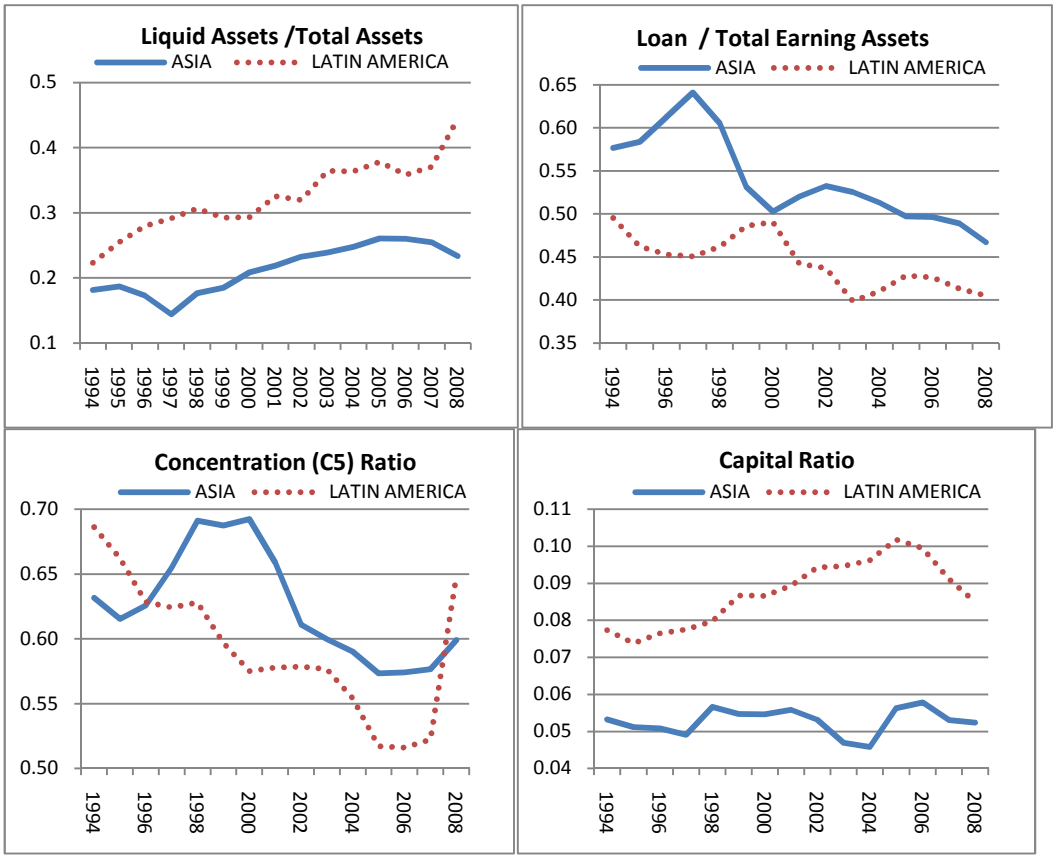
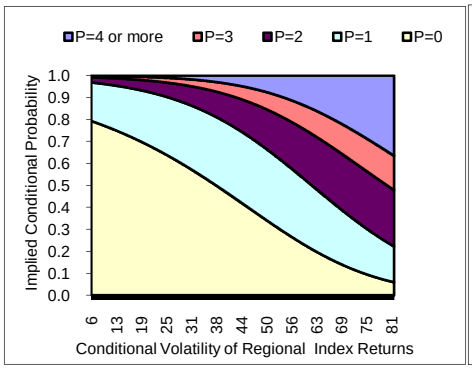
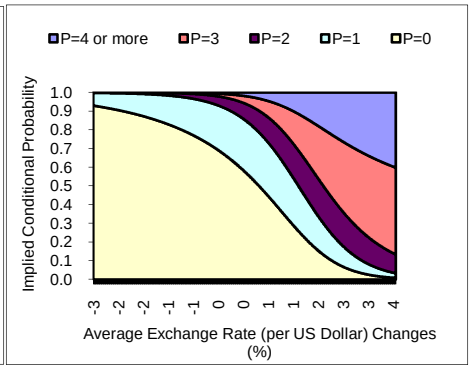


Figure 4.4(a): Coexceedance Response Curve of Negative Extreme Return in Asia to the Common Variables





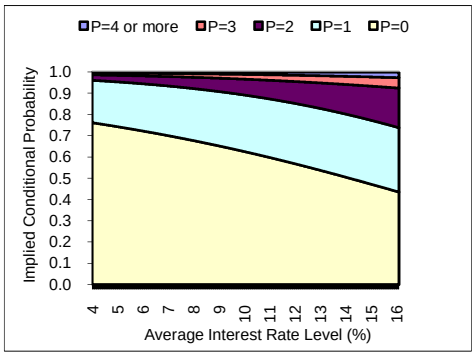


Figure 4.4(b): Coexceedance Response Curve of Negative Extreme Return in Asia to the Banking Characteristics

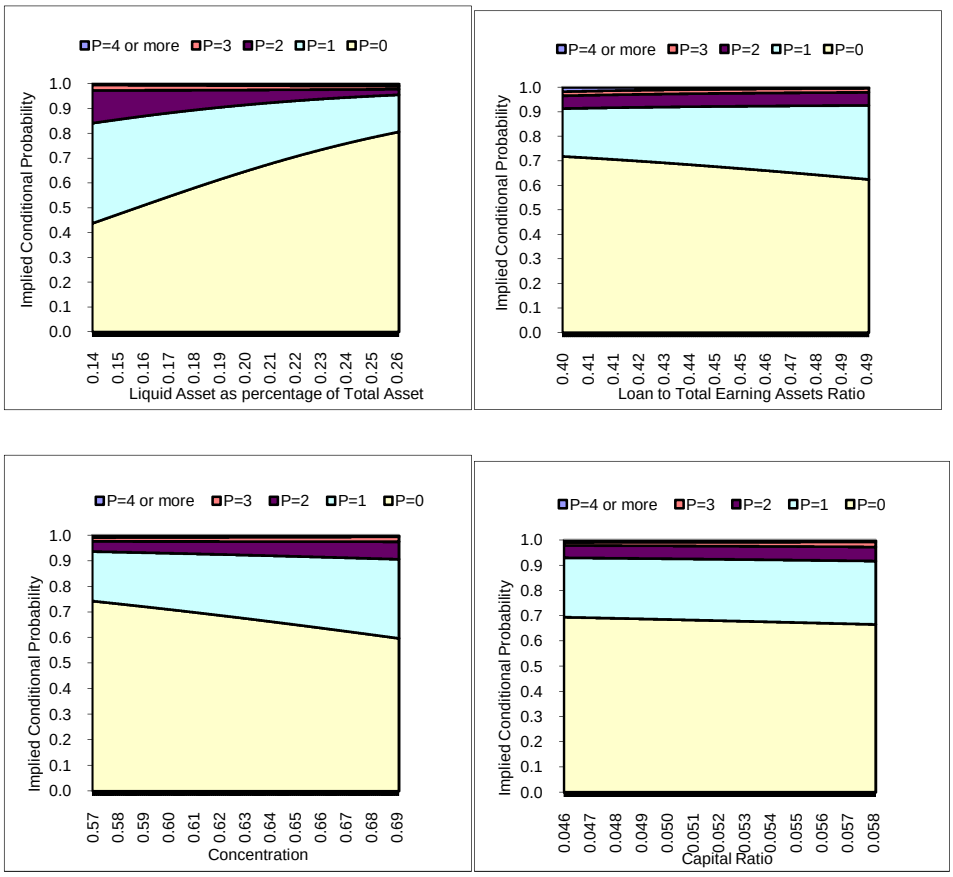


Figure 4.5(a): Coexceedance Response Curve of Negative Extreme Return in Latin America to the Common

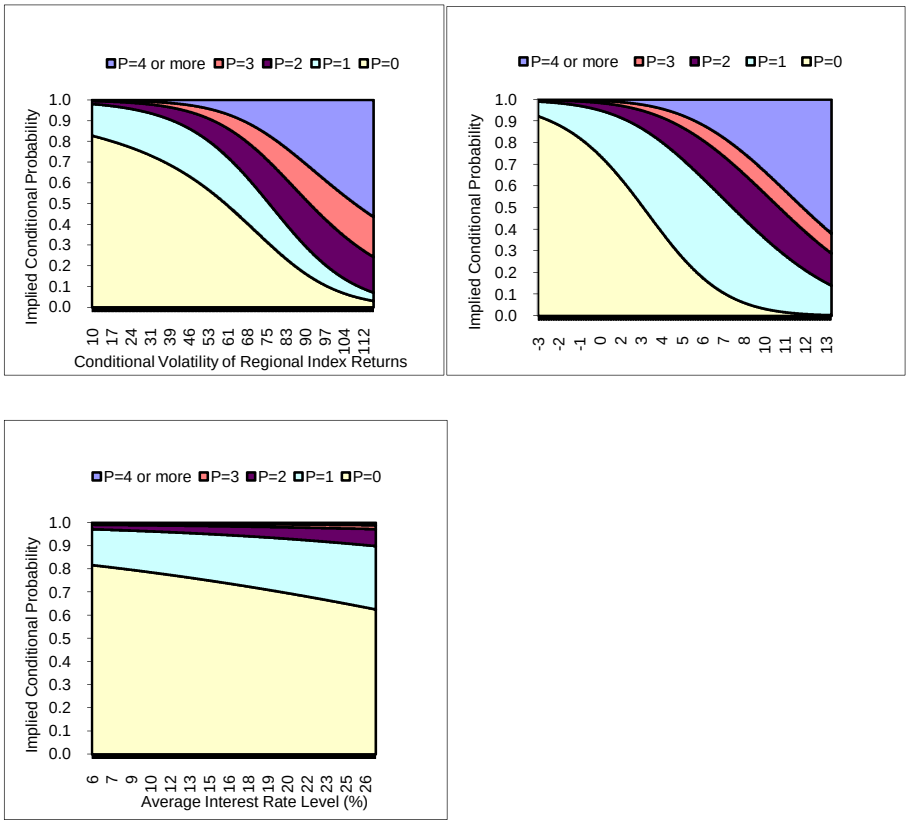


Figure 4.5(b): Coexceedance Response Curve of Negative Extreme Return in Latin America to the Banking

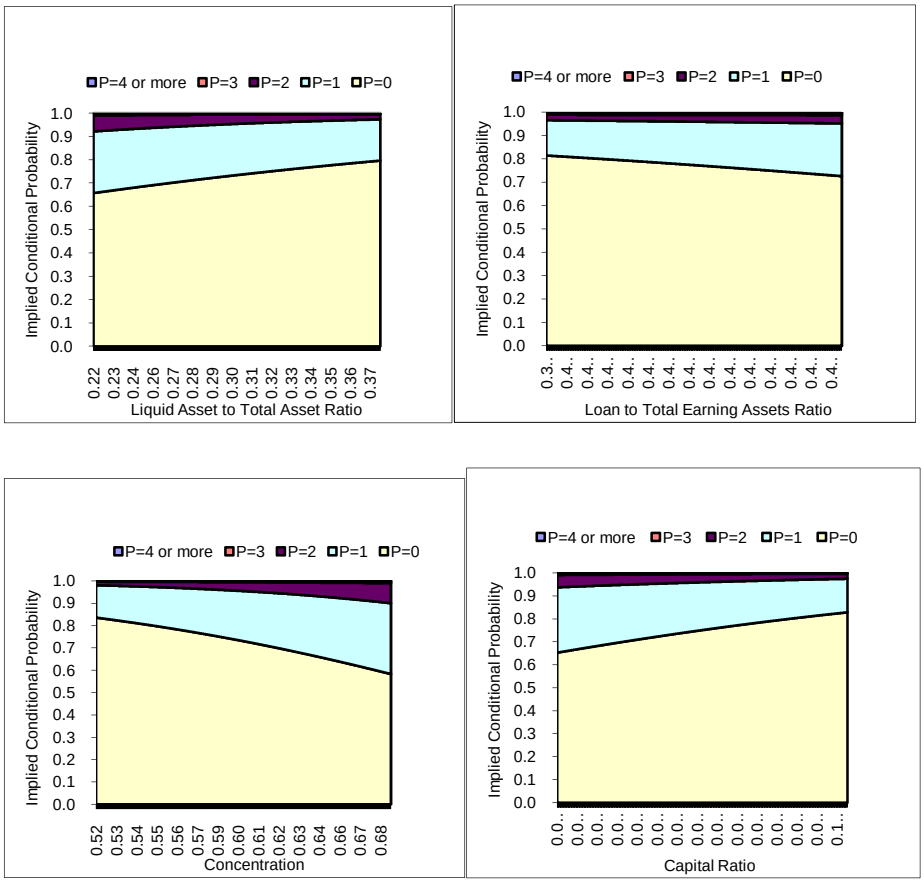


Figure 4.6(a): Interaction Effect of Cross-Regional Contagion and Banking System Characteristics in Asia

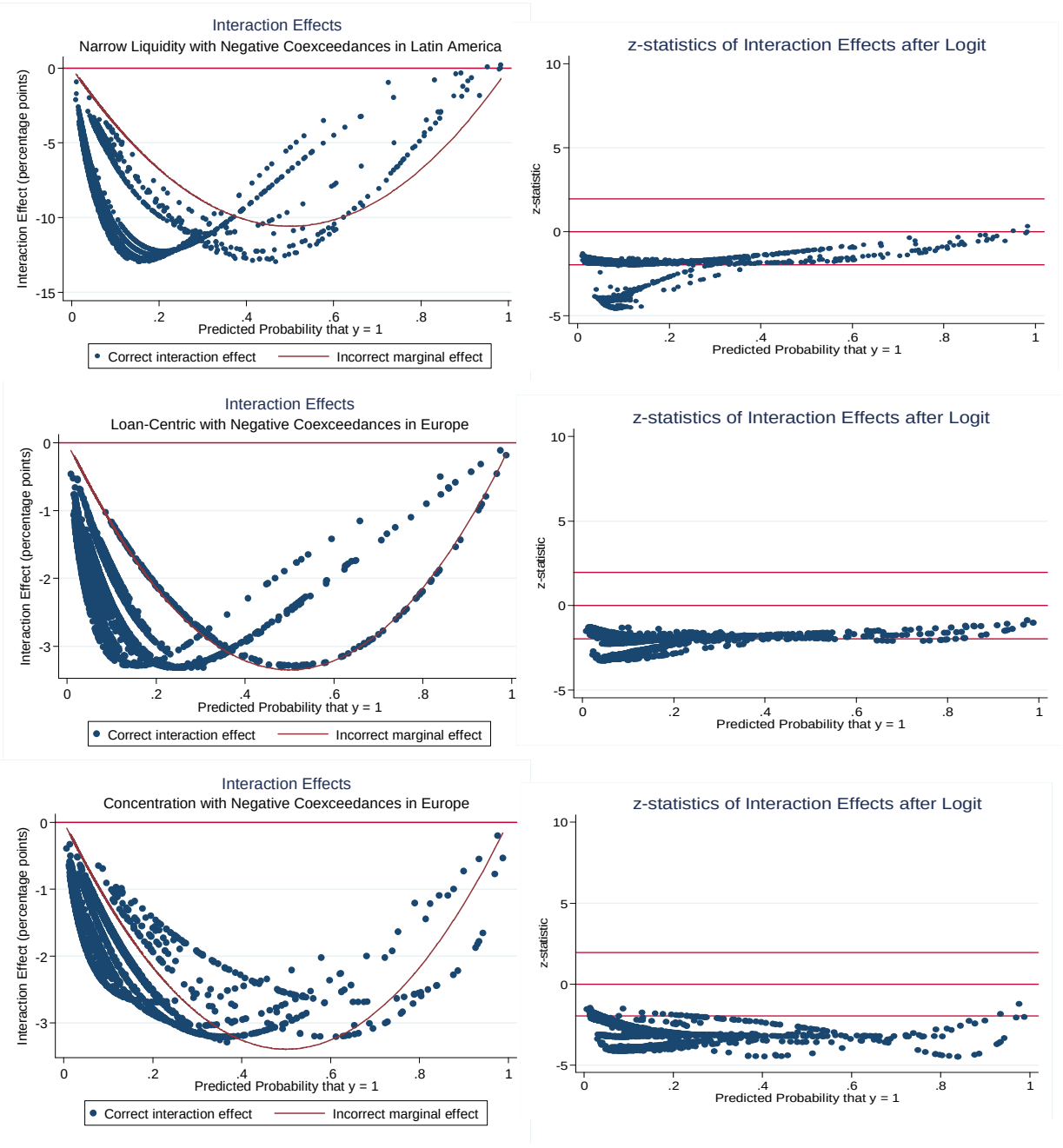
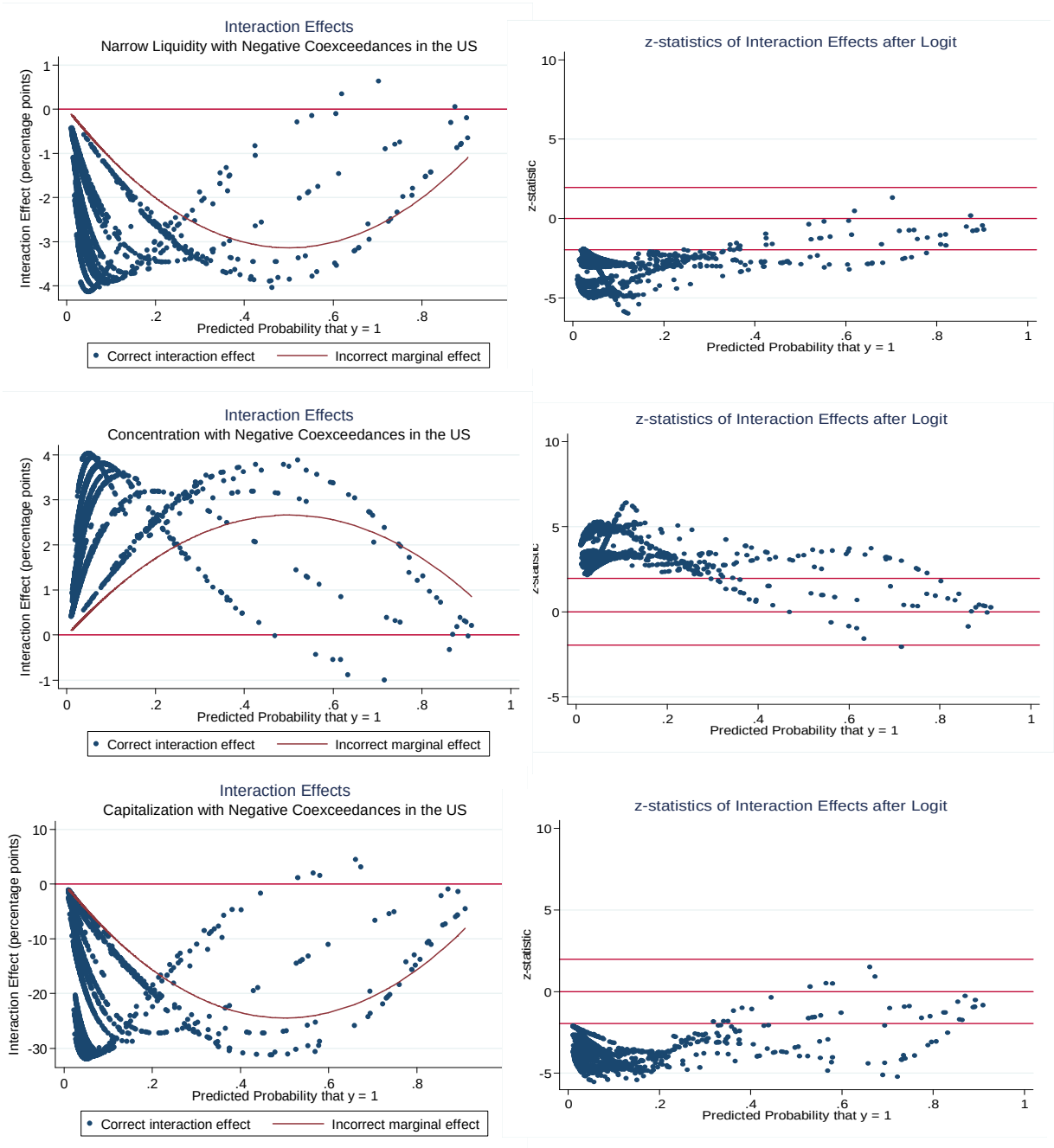


Figure 4.6(b): Interaction Effect of Cross-Regional Contagion and Banking System Characteristics in Latin America



5 AN INVESTIGATION OF INTER-INDUSTRY CONTAGION: BANKING AND FINANCIAL SERVICES INSTITUTIONS

Chapter 5 investigates the intra-industry and inter-industry contagion among banking and financial services industries. We use multinomial logistics regressions to explain the occurrences of 2 or more coexceedances in banking, financial services or both indices with common factors and banking system characteristics. We explore the potential of intra-industry and inter-industry cross-regional contagion after controlling for common factors and banking system characteristics. We find that the cross-regional intra-industry contagion is more prominent in banking institutions than in financial services institutions. Banks are more prone to receive cross-regional contagion as compared to financial services institutions. Cross-regional contagion is higher in Asia than in Latin America. In Asia, the economic magnitude of inter-industry contagion from financial services indices is highest when it is triggered from Europe. In Latin America, the inter-industry contagion effect from financial services indices is highest when it is triggered from the US, but is only slightly lower when the contagion is triggered from Europe. However, in general, the cross-regional effect from Europe is more dominant than the cross-regional effect from the US.

5.1 INTRODUCTION

The wave of market integration during the last decade has brought both advantages and disadvantages due to much stronger linkages of domestic economies with the international financial environment. The financial markets have become more inter-connected which results in a higher degree of co-movements in financial indices. This phenomenon has been studied by researchers with the aim of better understanding financial contagion (for example, Bae, Karolyi and Stulz (2003); Gropp, Duca and Vesala (2009)). These studies limit their analysis either to general financial indices or to the same industry (i.e. intra-industry contagion). But there is very little evidence on the effects of shocks in one industry to another industry (i.e. inter-industry contagion). The inter-industry contagion is important because financial liberalization has blurred the distinction between various types of financial activities. Resultantly, the emergence of financial conglomerates has paved the way for contagion from one industry to another. For example, many banks own special purpose vehicle/entities (SPV/SPE) to cater the niche demand for mortgage, insurance and underwriting services. Though banks do not lend significantly to these special purpose vehicles, their ownership interests are potentially more significant.

Therefore, there are several direct channels through which these subsidiaries might affect their parent institutions: i.e. via reductions in banks' operating incomes, via the cost of re-capitalization and via the direct effect on banks' Tier 1 capital of any change in the 'embedded value' of a life insurance subsidiary (Stringa and Monks (2007)). Similarly, write-offs on the portfolio of sub-prime mortgages through mortgage firms. Furthermore, these subsidiaries have the potential to indirectly affect banks through capital markets and consumer confidence channels.

Since the banking sector is a cornerstone of the financial system in any country, the crisis in the banking sector has serious effects on the domestic and international economy. Therefore, it is important to identify likely channels of contagion, in order to monitor them and help mitigate the risk of financial crises. That is why, a number of studies focus on the nature and the causes of co-movements in equity prices/financial indices of banking systems to evaluate contagion (for example, Degryse, Elahi and Penas (2010)). The recent sub-prime crisis further stresses the need to evaluate the contagion not only within the banking sector, but also contagion across industries. Banks involvement in mortgage activities through special purpose vehicles also increase the likelihood of an idiosyncratic risk in the mortgage market spread through the whole financial system at home and abroad in no time. Contagion from the non-banking financial sector to the banking system may potentially have relevant implications for financial stability. Consequently, it is important to identify the inter-industry contagion potential together with intra-industry contagion potential, in order to monitor them and help mitigate the risk of financial crises.

In this chapter, we focus on both the intra-industry and inter-industry contagion effects in Asia, Latin America, the US, and Europe. Our intuition for inter-industry contagion follows Lang and Stulz (1992) that firms using similar input to produce similar output are affected by the same shock irrespective of their industrial classification (SIC codes). More specifically, all financial institutions including banks are competing for the financial liquidity and sell similar financial products with different brands. Therefore, the inter-industry contagion may be as costly and important as the intra-industry contagion and need similar treatment to limit their adverse consequences.

The transmission channel for intra-industry contagion within banking is bank lending. This channel is particularly important when other means of funding is not available to corporate

customers. Beside bank lending channel the internal capital markets also provide channel for intra-industry contagion. Cetorelli and Goldberg (2008) using quarterly information from all US banks have shown that globalized banks activate internal capital markets with their overseas affiliates to insulate themselves partially from changes in domestic liquidity conditions. The existence of these internal capital markets directly contributes to an international propagation of domestic liquidity shocks to lending by affiliated banks abroad. On the other hand, the transmission channel for intra-industry contagion within financial services is rather weak. Financial services institutions are more connected with banks than among themselves. That is why; we find a higher degree of inter-industry contagion in financial services industry. The financial services institutions often have credit lines from banking institutions, these credit lines form transmission channel for inter-industry contagion.

Inter-industry contagion has been assessed before when studying the significance of spillovers from life insurance to the banking system in an extant literature [see Brewer and Jackson (2002) for the US and Stringa and Monks (2007) for UK]. Our analysis however is unique in terms of using a set of financial institutions. We include assets managers, consumer finance, specialty finance, investment services, mortgage finance, equity investment services and non-equity investment services in our analysis. Moreover, our analysis uses an explicit multinomial logistic framework to gauge the degree of intra-industry and inter-industry contagion while previous studies rely on event study methodology. Our method employs an approach to assess the significance of spillovers from either directions between the financial services sector and the banking system during times of stress. The spillovers are originated from direct channels – i.e. counterparty exposures – and/or from indirect channels via the impact of adverse and unexpected news on financial markets (Kaminsky and Reinhart (2000)) and consumers' confidence (Diamond and Dybvig (1983)). Even though accounting data provide accurate information about interlinkages via direct channels (counterparty exposures) they are not useful in estimating spillovers through indirect channels. In contrast, equity price co-movements capture contagion effect through all possible channels.

We find that the cross-regional intra-industry contagion is more prominent in banking institutions than in financial services institutions. Banks are more prone to receive cross-regional contagion as compared to financial services institutions. Cross-regional contagion is higher in

Asia than in Latin America. In Asia, the economic magnitude of inter-industry contagion from financial services indices is highest when it is triggered from Europe. In Latin America, the inter-industry contagion effect from financial services indices is highest when it is triggered from the US, but is only slightly lower when the contagion is triggered from Europe. However, in general, the cross-regional effect from Europe is more dominant than the cross-regional effect from the US.

The remainder of this chapter is structured as follows. In the following Section, we illustrate our data set and discuss dependent and control variables. Section 3 deals with methodology. Section 4 presents results and finally we conclude in Section 5.

5.2 DATA, DEPENDENT VARIABLE AND CONTROL VARIABLES

Stock prices in addition to accounting data have been extensively used to assess fragility of financial markets (see e.g. Bongini, Laeven and Majnoni (2002), Gropp, Vesala and Vulpes (2004), Gropp, Vesala and Vulpes (2006), Yu-Fu, Michael and Kadri (2006)). Stock market valuations reflect future economic activity; therefore, a simultaneous decline in banking indices in a region reflects an increase in regional banking system fragility. We use stock prices of banking institutions and financial services institutions from Datastream starting from July 1, 1994 to December 31, 2008 (3784 daily observations). Degryse, Elahi and Penas (2010) provide all details on the construction of banking indices and coexceedances at regional level in order to assess banking system fragility. In this chapter, we construct financial services indices and use banking system indices from Degryse, Elahi and Penas (2010) for inter-industry analysis.

<please insert table 5.1 here>

Datastream uses Industry Classification Benchmarks (ICB) for the classification of financial services institutions. These institutions exclude all banking, insurance and real estate firms; that is, we include assets managers, consumer finance, specialty finance, investment services, mortgage finance, equity investment services and non-equity investment services.[21] Following Bae, Karolyi and Stulz (2003) we use data from 10 Asian and 7 Latin American countries in addition to the United States and Europe (Europe is considered as one region in this analysis). We construct value-weighted indices of financial services institutions (excluding banks,

[21] See Appendix 1 for details of Industry Classification Benchmark (ICB) for financial services.

insurance and real estate) for each country. Table 5.1 shows the number of institutions from each country and also provides sample statistics including correlations for the full sample period. In total, we have 366 institutions from Asia, 104 from Latin America, 45 from the US and 204 financial services institutions from Europe. We find that the marginal daily return on financial services indices varies across countries and over time. The average marginal daily return is highest in Asia with 0.114% followed by 0.077% in Latin America, 0.044% in the US and 0.034% in Europe. We also observe that cross-country variation in marginal daily return is higher in Asia than in Latin America.

More specifically, In Asia, Pakistan has the highest average daily return (0.202%), followed by India (0.174%) and China (0.155%). On the lower side, Taiwan has the lowest average daily return (0.029%). Moreover, China, Korea and Thailand are highly volatile markets in Asia. Whereas In Latin America, Brazil and Venezuela are found to be on the higher side of average daily returns with 0.145% and 0.139% respectively. The daily marginal returns on financial services indices are also very volatile in these countries with standard deviations of 2.685% and 2.171% in Venezuela and Brazil respectively.

Correlation among financial services indices daily returns is higher within Asia (i.e. 0.077) than in Latin America (i.e. 0.053). Beside within region correlations, we also calculate correlations across regions. We find that financial services industry in Latin America is more connected with the United States and Europe as compared to Asia. The correlation coefficients for Latin America with the United States, Europe and Asia are 0.141, 0.146 and 0.036 respectively. On the other hand, the daily marginal return on financial services indices in Asia are more aligned with marginal daily returns in Europe (with correlation coefficient equal to 0.132) and marginal daily return of the preceding day in the United States (with correlation coefficient equal to 0.115). Moreover, we find that correlations are high among neighboring countries and more open economies in Asia. Specially, marginal daily return in Malaysia has high correlations with most other countries in Asia and the marginal financial services industry Pakistan has highest correlation with marginal daily return in India. Similarly in Latin America, marginal daily returns of financial services in Brazil have highest correlation coefficients with all other countries except for Venezuela, which has high correlation with Argentina and Chile. Since trading starts in Asia and ends in Americas on a given day. So the information available in

America at noon is not available to Asia on the same day. Therefore, in line with Bae, Karolyi and Stulz (2003), we also report correlation coefficients of marginal daily returns in financial services indices in Asia with the previous trading day behavior in Americas. We find a higher correlation of daily return in Asian markets with the previous day's daily return in the United States.

5.2.1 Tail behaviour of banking and financial services indices

Since our main interest is on the fragility of banking and financial services institutions, we focus on the behavior of negative tail of the distribution of daily returns on banking and financial services indices. We follow the view that extremely low (negative) market return reflects problems in the financial sector on each day. We define extreme low return as the returns that are below the 5th percentile of daily return distribution and refer to this as an *exceedance* of the return on the financial services index. Since we have 3784 daily observations of financial services index for each country; therefore the lowest 5% returns (or 5^{th} percentile) is the 190^{th} observation during the entire sample period for each country when returns are arranged in ascending order. We use the 5^{th} percentile observation as a threshold to decide whether a country on a particular day exceed or not. Then we construct a count variable indicating the number of countries in lower tail for each trading day in our sample. We also right trim the count variable and limit its range from 0 to 4, where 0 means no country in the region has negative extreme return on that trading day and 4 indicates 4 or more countries in the region have negative return simultaneously on a given trading day. When multiple countries have negative extreme return on a given day then we refer this phenomenon as *negative coexceedance of that industry in those countries.*

<please insert table 5.2 here>

Degryse, Elahi and Penas (2010) report coexceedance in banking indices during the same period. We use the same coexceedances in banking indices in this chapter. Moreover, in table 5.2, we report the frequency of count variable for 0, 1, 2, 3 and 4 or more joint occurrences of extreme low returns (coexceedances) within a region on a particular day. We also indentify which countries "participate" in those extreme events and how often. There are more negative coexceedances in Asia compared to Latin America. The higher coexceedances in Asia are expected on account of higher number of countries (10 Asian countries compared to 7 Latin

American countries). In our sample, we find that there are 2462 trading days when there is no negative extreme return in Asia compared to 2745 trading days when there is no negative coexceedances in Latin America. Similarly, there are 934 and 815 trading days when only one country witness extreme negative returns in Asia and Latin America respectively. On the extreme side, we find that there are 39 trading days when 4 or more countries coexceed in Asia compared to 14 days in Latin America. Malaysia has been the most recurring participants (30 out of 39 trading days) of the extreme event when 4 or more countries in bottom tail on a given day. On the other hand, Pakistan and China seldom participate in the extreme event trading days. In Latin America, Brazil, Chile and Mexico participate 13 times of the total 14 trading days when 4 or more countries in the bottom tail. Whereas, Venezuela has never been a country among 4 or more countries coexceed on a given trading day. We also report the daily return on the day of extreme event (4 or more countries coexceed) for all countries in our sample. We find that, in Asia, Korea has the highest negative returns (-7.32%, on average) whenever it is one of the countries that coexceed on a particular day. In Latin America, Brazil has the highest negative return (-6.27%, on average) if it includes in countries that coexceed. We have also found that the negative daily return is higher in Asia (-4.81%, average over all countries) compared to Latin America (-3.38%, average over all countries). Moreover, we have found clustering of coexceedances in financial services indices during 2008 for Asia and Latin America as shown in figure 5.1.

<please insert figure 5.1 and figure 5.2 here>

It is interesting to mention here that the coexceedances in financial services are highly correlated with the coexceedances in banking services indices from Degryse, Elahi and Penas (2010). We first make a visual investigation for inter-industry interdependence and check whether the coexceedances in banking indices lead to coexceedances in financial services indices or the vice versa. Figure 5.2 reports how often the coexceedances in banking indices are matched with coexceedances in financial services indices in the four regions. Blue columns represent the percentage of matched coexceedances against coexceedances in banking indices on the same day. The red columns show the percentage of coexceedances in banking indices that lead to coexceedances in financial services indices on the same day or the following day. The green columns represent the percentage of coexceedances in financial services indices that lead to

coexceedances in banking indices on the same day or the following day. To better understand these percentages we discuss one in detail. For example, in Asia, we investigate how often the coexceedances in banking indices are followed by coexceedances in financial services indices. We find that there are 379 trading days when 2 or more coexceedances are observed in banking indices. Out of 379 trading days, there are 179 trading days (about 47.2%) when 2 or more coexceedances in banking indices are matched with 2 or more coexceedances in financial services indices on the same trading day. It is also possible that the coexceedances in banking indices has an influence on financial services indices on the following day, therefore, we investigate further and find that there are 225 trading days (about 59.4%) when 2 or more coexceedances in banking indices are matched with 2 or more coexceedances in financial services indices either on the same day or the following day. Similarly, we check the occurrences of coexceedances in financial services indices that are followed by coexceedances in banking services indices. We find that there are 220 trading days (about 56.7%) when 2 or more coexceedances in financial services are matched with 2 or more coexceedances in financial services indices.

A similar analysis has been conducted for Latin America, the US and Europe as reported in figure 5.2. We find that the matching percentages are highest in the US that represents higher degree of inter-industry interdependence in the US; whereas these percentages are lowest in Latin America. However, the percentage of matching coexceedances is lower compared to other regions. Another interesting feature is that the inter-industry interdependence is higher from financial services to banking institution in all regions except Asia.

<please insert figure 5.3 here>

5.2.2 Dependent variable for inter-industry interdependence

In this case we refer to the state of financial fragility through the number of coexceedances in financial services as well as banking services indices. We consider four possible scenarios; first, when neither banking indices nor financial services indices has 2 or more coexceedances in a region (i.e. financial stability in banking and financial services industries); second, when there are 2 or more coexceedances in only the banking services indices (i.e. fragility in banking industry only); third, when 2 or more coexceedances in only financial services indices (i.e. fragility in financial services industry only); and finally the fourth, when 2 or more

coexceedances in both banking services and financial services indices (when both banking and financial services industries are fragile). Now we construct a category variable that takes value 1, 2, 3, and 4 to represent the state of financial fragility on that particular day in the region. Figure 5.3 illustrates how often each of these possible scenarios occurs in each region. In Asia, we find that 588 trading days (16% of total trading days in our sample) have 2 or more coexceedances in banking services or financial services indices or both. Out of 588 trading days, there are 179 trading days when both banking services and financial services have more than 2 coexceedances. Whereas in Latin America, there are 378 trading days when 2 or more coexceedances are observed in any of the banking or financial services indices; of which, only 79 trading days have both. This reiterates the low interdependence of banking and financial services in Latin America. On the other hand, in the US, we have observed the least number of trading days with 2 or more coexceedances (i.e. 246 trading days); however, the banking and financial services indices often have exceedances together. In other words, we can say that the banking and financial services have high degree of interdependence in the US. In Europe, we have similar result to the US; there are 258 trading days with exceedances and 122 trading days when both banking and financial services indices have exceedances simultaneously.

5.2.3 Motivation for control variables

In this chapter we are particularly interested in the evaluation of the fragility of financial services industry as a result of changes in common variables both within region and across regions. Since banks are not only closely inter-linked with financial industry but also provide major resources through special-purpose-vehicles, we assess regional fragility of financial services industry through regional economic fundamentals and characteristics of the banking system. We include three common variables as a proxy for economic fundamentals, “regional conditional volatility”, changes in the exchange rate, and interest rates in line with Bae, Karolyi and Stulz (2003). From regional banking system characteristics, we include banking system liquidity, diversification of banking activities, banking competition, and the capitalization of the banking system as control variables. In the remaining of this section, we briefly motivate each of these control variables.

5.2.3.1 Common shocks

Stock market volatility is negatively associated with overall stock returns (Whitelaw (2000), Bekaert and Wu (2000), Wu (2001) and Brandt and Kang (2004)). The higher conditional volatility corresponds to a higher probability of a declining market that has a negative impact on portfolio returns in general. Therefore, we expect that increase regional stock market volatility will result in higher number of joint occurrences of extreme negative returns in banking as well as financial services institutions. To evaluate the impact of stock market volatility we incorporate regional conditional stock market volatility as an explanatory variable in our model. Secondly, a sudden sharp depreciation of the domestic currency adds vulnerability to regional financial system. Large financial institutions that are usually operated in multiple regions with various currencies; often at high risk owing to an unexpected sharp movement in exchange rate. This notion has extensively debated in financial literature and report significant evidence that exchange rate risk exacerbate banking system fragility during crises (Kaminsky (1999), (Kaufman (2000), Hutchison and Glick (2000)). We incorporate the average of daily exchange rate changes of all countries in the region as an independent variable in our model to check its effect on the probability of coexceedances. Lastly, an increase in interest rate level would have a negative impact on profitability of financial institutions because of higher occurrences of non-performing loans. Therefore, ceteris paribus, an increase in interest rate level is likely to increase banking fragility. The interest rate level generally control the effect of business cycle variables including domestic inflationary pressures, increase in foreign interest rates, shift towards tight monetary policy and lax regulatory framework owing to financial liberalization (Galbis (1995)). We introduce interest rate level as a control variable in our model in order to isolate the effect of business cycle. In general, we expect that banking institutions are more inter-linked to the rest of the economy than other financial services institutions; therefore, banking institutions are more receptive of the common shocks. Moreover, the effect of the three common factors is not same for banks and other financial services institutions. For example, interest rate level has more importance in banking industry because of its immediate impact on banks' core activities. Similarly, the effect of exchange rate depends upon the magnitude of operations in other currencies, which are typically dominated by banks.

<please insert table 5.3 here>

In order to implement these control variables we use following definitions. For stock market volatility, we estimate the conditional variance of the stock market indices using a GARCH (1,1) and then take average of the all countries in a region for the regional conditional volatility. We use the International Finance Corporation (IFC) indices from Asia and Latin America for gauging stock market volatilities in these regions and the S&P 500 index for the United States and Datastream International Europe Index for Europe. In first column of table 5.3, we report mean and standard deviation of conditional volatility over the entire sample period. We find that stock market in Latin America is more volatile with conditional volatility of 23.39 percent compared to 21.19 percent in Asia. The second common factor that we control for is the change in exchange rate. We calculate the daily change in exchange rate against US dollar for each country in Asia and Latin America. In case of the US, we use a basket of four currencies (i.e. GBP, JPY, CHF and EUR) to valuate exchange rate changes. For Europe, since EUR and GBP are the two major currencies, we take equal-weighted average of EUR and GBP exchange rates changes against USD.[22] Similarly daily change in exchange rate is also on the higher side in Latin America compared to Asia as shown in column 2. Finally, we use the 1-year interbank interest rate level as third common factor. For regional representations, we compute equal-weighted average of interest rate level in countries within each region. We also find a high volatility including higher interest rate level in Latin America (4.86 percent) compared to Asia (2.84 percent). Figure 5.4 compares the trend of common factors in the sample period for Asia and Latin America. We find that conditional volatility increases significantly in both regions during the last two years, which is expected on account of turbulence in stock markets after sub-prime crisis. We find that daily exchange rate changes though volatile but remain under 5 percent in our sample except for the crisis period (Asian crisis 1997 and Argentina crisis 2002). Interest rate level declines in both regions till 2004 and then a moderate increase in recent years.

<please insert figure 5.4 here>

5.2.3.2 Banking system characteristics and regional financial system fragility

Following are the banking characteristics that play a role in determining the fragility of the financial system including financial services institutions. We compute these banking

[22] Since our sample starts from June 1994; therefore, we use country-weighted average of exchange rate against USD of euro currencies for daily observations prior to the introduction of EUR.

characteristics based on annual balance sheet data of banks in each individual country from *Bankscope*.[23] Since these variables are available on annual basis, we use the annual value of the preceding year for all daily observations of the current year. Moreover, the regional values are calculated by averaging individual country level data. The regional banking system characteristics are weighted-average of individual countries.

5.2.3.2.1 Aggregate banking system liquidity

Aggregate banking system liquidity is the first line of defense against liquidity shocks. Financial services institutions also park corporate funds through interbank markets; therefore, from a macro perspective, adequate levels of liquidity should be maintained to absorb any sudden shock. The lack of aggregate liquidity at the banking system level may lead to a channel of contagion that not only affects banking system but also financial services industry across regions. We therefore include aggregate banking system liquidity in our analysis, and investigate its impact on regional fragility of financial services institutions. We use a narrow definition of liquidity, that is, the ratio of cash and cash equivalent assets to total assets. We call this variable 'liquidity' hereafter. We find that banking system in India and Pakistan are holding high cash reserve relative to total assets. The cash holdings of India and Pakistan are 12.55 percent and 11.56 percent of the total assets respectively compared to 2.8 percent on average in Asia. Similarly, in Latin America, Venezuela holds 10.6 percent of the total assets as cash or cash equivalent compared to regional average of 2.88 percent.

5.2.3.2.2 Diversification of banking activities

De Nicoló, Bartholomew, Zaman and Zephirin (2004) provide evidence that the increase in financial conglomeration encourages banks to move away from traditional commercial banking activities and offer a range of financial instruments that directly compete with the offerings of financial services institutions. Whether the resulting overlap between banks and financial services institutions would increase fragility or provide stability to the financial system as a whole is an intriguing question. More recently, De Jonghe (2010) finds that banking system fragility, measured through an increase in banks' tail beta, aggravates when banks engage in non-traditional activities in addition to their core commercial banking activities. Since interest

[23] From *Bankscope*, we retrieve data for all banks from 1994 to 2008 for each region. We find that some banks report both consolidated and unconsolidated accounts in the bank scope. Therefore, in order to eliminate double entries, we use consolidated accounts when available, otherwise unconsolidated accounts.

income is less risky than other revenue streams, it is argued that specialization in traditional activities result in lower systemic banking risk. In that sense, financial conglomeration is unable to reduce systemic risk. Wagner (2006) and Wagner (2010) theoretically argue that multiple activities of commercial banks though reduce risk at individual bank level, but from the financial system's point of view it raises the likelihood of systemic crisis because a shock that previously affect only a small part of the financial system, now affects a large portion of the system and possibly results in failure of the whole financial system. In this strand of literature we find a tilt that banks should focus on their core loan-making business because diversification increases banking system fragility. However, in this analysis, we are also interesting in testing the hypothesis whether diversification in banking activities increases or decreases regional fragility of financial services industries. Our conjecture is that the diversification in banking would give more resources to non-bank financial services firms and hence provide stability in the financial services industry. In order to measure the extent to which banks are involved in traditional loan-making activities compared to non-traditional activities, we calculate net loans to total earning assets for each country and label it as 'diversification' in our results. We find that net loans are about half of the total earning assets in almost all countries; however, the focus on loan-making activities is slightly higher in Asia (53.96%) compared to Latin America (44.40%).

5.2.3.2.3 Competition in banking industry

The existing literature on the relationship between competition and stability is inconclusive. There exists "Competition-Fragility" view that more competition leads to lower loan rate and lower profit margins. Consequently lower revenues from performing loans makes banks operations more risky and ultimately increases fragility of the whole financial system (Marcus (1984); Keeley (1990); Demsetz, Saidenberg and Strahan (1996)). Alternatively, the "Competition-Stability" view suggests that competition lead to lower interest rates, which in turn lead to lower probability of loan default, and hence safer banks (e.g. Boyd and De Nicolo (2005)). In order to evaluate how competition affect fragility of banking and financial services institutions, we use the ratio of total assets of biggest five banks to total assets of all banks as a measure of competition (i.e. C5 measure) for each country in the region. We label it as 'concentration' in our analysis. The regional measure is the weighted average of individual country in the region using banking system total assets as relative weights. We find that banking systems in Asia are, on average, relatively more concentrated than the ones in Latin America. Sri

Lanka, China and Pakistan are among most concentrated banking systems in Asia, whereas Peru, Venezuela and Chile are highly concentrated banking systems in Latin America.

5.2.3.2.4 Capitalization of the banking system

Lastly, the ability of banking systems to absorb foreign shocks depends on the degree of capitalization of the banking system. Ceteris paribus, a more capitalized banking system should be more stable because a higher capital base provides a cushion against insolvency. Liu and Mello (2008) argue that fulfilling the capital requirements at individual bank level is not sufficient to prevent systemic crisis. We use the capital base of the banking system as a whole to evaluate whether the capital base of the banking system provides a cushion against regional fragility of financial system including banks and financial services institutions. Our measure of capital is the total equity that includes common shares and premium; retained earnings; reserves for general banking risks and statutory reserves; loss absorbing minority interests; net revaluation of AFS securities; FX reserves included in equity and revaluations other than securities deemed to be equity capital. We label it as 'capitalization' in our results. We find that banking systems in Asia, on average, maintain low capital to total asset ratio compared to Latin America.

<please insert table 5.4 here>

Table 5.4 shows the mean and standard deviation for banking characteristics for each country as well as at regional level during the whole sample period. We find that Latin America has more liquid asset as percentage of total assets compared to Asia. Moreover, Asia focus more on traditional banking activities (loan business), higher concentration in banking activities and relatively lower capital ratio compared to Latin America at regional level. As far as the time dimension is concerned, figure 5.5 shows that there is an increasing trend in liquid asset to total asset ratio in both Asia and Latin America. We also observe a decline in traditional banking activities (loan business) in both regions over time. There is no particular trend in concentration of the banking industry. Lastly, capital ratio has increased from around 8 percent to 10 percent in Latin America and hovered around 5 percent in Asia.

<please insert figure 5.5 here>

5.2.3.3 Inter-industry and intra-industry contagion

We evaluate intra-industry and inter-industry contagion after controlling for common variables. Inter-industry contagion is important because both banks and other financial services institutions are trading the same stuff; therefore, they are jointly exposed to the same junk products. Moreover, the non-bank financial institutions have different roles in different regions. For instance, in the US, since the passage of the Gramm–Leach–Bliley Act in 1999, non-bank financial institutions have very similar operations as banks, so much so that they can raise deposit directly from the public. However, in other regions, non-banks financial institutions are not allowed to raise deposit directly. These differences in operational environment may have an impact on inter-industry cross-regional contagion.

In this context we differentiate intra-industry and inter-industry contagion by origin of shock and its consequence. When the triggering and recipient industries are same, it is called intra-industry contagion. We refer intra-industry contagion when the change in probability of banking system fragility is due to shock in the banking system. On the other hand, when triggering and recipient industries are different, it is called inter-industry contagion. For example, if probability of banking system fragility is affected due to shock in financial services industry, then we call it inter-industry contagion. For contagion within region, we are interested in intra-industry contagion of financial services institutions; however, across regions, we investigate inter-industry contagion as well as intra-industry contagion among financial services and banking institutions.

5.3 METHODOLOGY

In existing literature, there are very few studies that specifically investigate inter-industry contagion. We find that Brewer and Jackson (2002) and Stringa and Monks (2007) study inter-industry contagion between banks and life insurance companies in the US and UK respectively. These research papers use event-study methodology to investigate cumulative abnormal returns around some given announcement events. The inference through event study methodology is based on strict assumptions about modeling the abnormal returns. More recently, Bernoth and Pick (2009) use panel data estimation to forecast the financial fragility of banks and insurance companies. We use multinomial logistics models to assess how fragility of banking and financial services institutions is affected by common factor, banking system characteristics and cross-

regional contagion. The dependent variable in our model is a count variable that is linked to the number of coexceedances in financial services and banking services indices in a region on a given day. Our methodology is an extension of Bae, Karolyi and Stulz (2003) and Gropp and Moerman (2004), wherein we use a different specification of dependent variable that explains the tail behavior of both banks and financial services indices using number of coexceedances in the region. We estimate financial fragility in banks, financial services indices or both as a function of common macro variables and banking system characteristics. The general multinomial logistics can be illustrated as:

$$P_i = \frac{G(\beta_i' x)}{1+\sum_{j=1}^{m-1} G(\beta_j' x)} \quad (1)$$

where x is the vector of covariates and β_i the vector of coefficients associated with the covariates, $G(\beta_i' x)$ is a logistic distribution and m is the number of categories in the multinomial model. The model is estimated using maximum log-likelihood function for a sample of n observations as follows:

$$\log L = \sum_{i=1}^{n} \sum_{j=1}^{m} I_{ij} \log P_{ij} \quad (2)$$

where I_{ij} is an indicator variable whose value is equal to 1 if the i^{th} observation falls j^{th} category and 0 otherwise. In our case, we have four categories i.e. 1, 2, 3, and 4; each representing the state of financial fragility in banking and financial services industries as mentioned in section 5.2.2.

For the simplest case of constants only, we estimate four parameters. We introduce additional variables like conditional volatility, exchange rate changes, etc. in various models. But for each additional variable introduced in the model, we need to estimate additional parameters; therefore, we opt for parsimonious specification as much as possible. Moreover, the coefficients from discrete choice models are difficult to interpret, therefore, we report marginal effect that are obtained by differentiating the probability for each outcome with respect to unit change in independent covariate on a given day being evaluated at unconditional mean value of independent variables. Since marginal effects in non-linear models are different for each set of data points in explanatory, we need to be careful in making inferences based on single set of observations (see Kolasinski and Siegel (2010) for recent discussion on this issue). The marginal

effect can sometimes even change signs; therefore, we compute the response of probability measures to the full range on values of independent variables. The sum of probabilities of all four categories must equal to 1 and we show the responses of probabilities across whole range of independent variables through “coexceedances response curve”.

In order to evaluate the inter-industry cross-regional contagion, we introduce the number of coexceedances in banking and financial services indices in other regions in separate models. After controlling for the common shocks and banking system characteristics, the marginal change of coexceedances in other region would signal cross-regional contagion in the same industry as well as other industry.

5.4 RESULTS

A higher number of coexceedances indicate fragility of the financial system. In this chapter, we evaluate the potential of inter-industry contagion through the number of coexceedances in financial services and banking indices within region and across regions. We label regional fragility when two or more coexceedances occur in Asia or Latin America (the definition applies to both financial services industry and banking system). In the case of the US and Europe, the regional fragility refers to the exceedance of banking or financial services indices. Our dependent variable captures the state of regional fragility in financial services industry and/or banking system. We assess how banking system characteristics and macro factors affect the regional fragility.

<please insert table 5.5 here>

Table 5.5 provides estimation results using a multinomial logistic model. We report the estimation result for Asia and Latin America. In the first column, we report the relative frequencies for all categories of our dependent variables. Since there are no covariates, the relative frequencies represent the probabilities of the respective outcomes. In Asia, the probability of no regional fragility in banking or financial services industry is 84.46%. We also find that the probability of regional fragility in banking system and financial services industry are 5.29% and 5.52% respectively. However, the probability of worst event that both banking system and financial services industry have more than two coexceedances on a particular day is 4.73%. Similarly, in Latin America, the probability of no regional fragility is 90.01%, probability for

regional fragility of banking system is 4.07%, probability for regional fragility of financial services industry is 3.83% and the probability for regional fragility in both banking system and financial services industry is 2.09%. We find that the probability of regional fragility in either industry is higher in Asia compared to Latin America.

5.4.1 Common factors and regional fragility in banking and financial services

In model 1 of table 5.5, we explain regional fragility in banking and financial services industry by including conditional volatility, changes in daily exchange rates and interest rate level at regional level. We report marginal effects to evaluate the impact of a unit increase in control variable for each category of our dependent variable. We find that an increase in the conditional volatility adds fragility in the banking system and financial services industry in all regions. The effect of an increase in conditional volatility is positive for all cases; however, the economic significance is highest for the fragility in financial services industry. The 1% increase in conditional volatility increases the probability of regional fragility of banking systems by 0.23%; regional fragility of financial services industry by 0.27% and 0.25% increase in probability of regional fragility of banking system and financial services industry together. We also check in the same model whether the fall in currencies, on average, increase the probability of financial fragility in banking and financial services industry. We find that an increase in daily exchange rate has the highest economic magnitude among all common factors in Asia. The 1% depreciation of domestic currencies, on average, increase the probability of regional fragility of banking system and financial services industry by 3.79% and 4.33% respectively. On the extreme case, a same depreciation of domestic currencies would lead to increase in probability of higher coexceedances in banking system and financial services industry together by 6.98%. Moreover, we evaluate the effect of monetary policy on financial fragility by inserting interest rate level as control variable in the same model. We find that the increase in interest rate level would significantly increase financial fragility in all cases. The 1% increase in interest rate level would increase the probability of regional fragility in banking by 0.98%, the probability of regional fragility in financial services industry by 0.39%, and the probability of regional fragility in both banking and financial services by 0.36%. All partial derivatives are significant at the 1% level and the pseudo-R^2 is 11%.

Similarly, in Latin America, we find that the increase in conditional volatility increases the probability of the regional fragility of banking system and financial services industry. The depreciation of domestic currencies, on average, has significant impact on the probability of regional banking system fragility but fails to affect the probability of regional fragility in the financial services industry. It also affects the probability of fragility in both banking and financial services industry together. Last but not the least; interest rate level has a significant impact on the probability of regional banking system fragility only. In terms of economic magnitude, the 1% increase in conditional volatility would increase the probability of regional fragility in banking system by 0.13%, the probability of regional fragility in financial services by 0.11% and the probability of regional fragility in both industries together by 0.08%. The marginal effects are significant at the 1% level and the pseudo-R^2 is 10%.

To summarize, we find that all common factors have a significant impact on banks and financial services in Asia. An increase in regional conditional stock market volatility, a fall in currencies and a rise in interest rate levels significantly increase financial fragility in both banking and financial services industries in Asia. In Latin America, conditional volatility affects both industries but exchange rate depreciation and interest rate level affect only the banking system. This is in line with our expectation that interest rate and exchange rate would have higher implications for banking system than financial services institutions. In terms of economic significance, we find that exchange rate depreciation has the highest impact in Asia and Latin America. Moreover, we find that the common variables collectively explain around 10% variation of the regional fragility in banking and financial services industries (pseudo-R^2: 11% in Asia and 10% in Latin America).

5.4.2 Banking system characteristics and regional financial fragility

Beside common factors there are banking system characteristics that affect both banks and financial services institutions in a similar fashion. Because our main focus is to investigate the inter-industry contagion, we also study the effect of banking system liquidity, diversification in banking activities, competition in the banking industry and capitalization of the banking system. We include these regional banking system characteristics in our previous multinomial logistic regressions in addition to common macro factors. We introduce banking system characteristics

one by one in successive models while controlling for common macro factors. In Model 2 to Model 5 of table 5.5, we report our estimation results for Asia and Latin America.

5.4.2.1 Banking System Liquidity

Banking system liquidity is important not only for individual banks to get funds from the money market without paying extraordinary premiums, but also provide opportunity to non-bank financial services institutions to manage their liquidity. The sufficient level of aggregate banking system liquidity would improve the efficiency of interbank market. We test the hypothesis whether the increase in aggregate banking system liquidity would reduce the probability of financial fragility in banking or financial services industry. We use cash and cash equivalent as percentage of total assets as a measure of liquidity. In model 2 of table 5.5, we report the effect of the liquidity on the probability of financial fragility in banking and financial services industry. The results are in line with Degryse, Elahi and Penas (2010) that increase in liquidity would reduce financial fragility.

In Asia, we find that a higher liquidity significantly reduces the probability of financial fragility of banking, financial services and both. But in terms of economic magnitude, the effect is much higher for banking system than the financial services industry. We find that 1 standard deviation increase in liquidity would decrease the probability of 2 or more coexceedances in banking indices by 0.439%, 2 or more coexceedances in financial services indices by 0.106% and 2 or more coexceedances in both by 0.192%. But in Latin America, liquidity significantly reduce the fragility of banking system only (i.e. 1 standard deviation increase in liquidity reduce the probability of 2 or more coexceedances in banking system by 0.104%). Liquidity does not have any significant impact on financial service industry or both industries together. With the inclusion of liquidity of banking system, the pseudo-R^2 has increased from 11% and 10% to 12% and 11% in Asia and Latin America respectively. The effect of liquidity is more significant in Asia compared to Latin America. Moreover, among industries, we find that the liquidity has higher impact on banking system compared to financial services industry. In Asia, the banking system provide more liquidity to the financial services institutions, that is why, we observe that a liquidity shock that affect banking system would have higher likelihood of affecting the financial fragility of financial services institutions as well. In Latin America, liquidity affects only the banking system fragility with no significant impact on financial services institutions.

5.4.2.2 Diversification in Banking Activities

There is an inconclusive debate about the role of diversification in banking activities on fragility of the banking system. Recently, De Jonghe (2010) argue that financial stability reduces when banks engage in non-traditional activities in addition to their core commercial banking activities. But Degryse, Elahi and Penas (2010) find no significant impact of bank's focus on traditional loan making activities on the regional fragility of banking systems. In this analysis, we use loan to total asset ratio in order to investigate whether the banks inclination towards traditional loan-making activities would affect the probability of financial fragility in banking and financial services industries. We use loan to total earning assets ratio as a proxy for banks' focus on traditional loan-making activities (i.e. level of diversification). In model 3 of table 5.5, we report the effect of the focus on loan-making activities on the financial fragility of banking and financial services industries in Asia and Latin America. We do not find any significant effect of an increasing focus on traditional loan making activities on financial fragility in banking or financial services in Asia. However, in Latin America, we find that traditional loan-making activities increase the probability of fragility in banking system only. In term of economic magnitude, we find that 1 standard deviation increase in traditional loan-making activities would increase the probability of banking system fragility by 0.640%.

Our findings are in line with Barth, Caprio and Levine (2006) surveys about the impact of bank regulation on bank performance and financial stability. They conducted three surveys during the last decade and reported key characteristics of banking environment in each country. These surveys report that, in general, bank's ownership in non-financial firms is more restricted in Asia than in Latin America, which means that there is less scope for diversification in Asia compared to Latin America. Moreover, the percentage of foreign-owned banking system assets to total banking assets is comparatively low in Asia as well. These restrictions provide less room for diversification in banking activities, and hence, this variable fails to affect the fragility of either banking system of financial services in Asia.

5.4.2.3 Competition in Banking Industry

Similar to the effect of diversification in banking activities, there exist divergent views on the effect of competition on regional fragility of banking system and financial service industries (i.e. the competition-fragility view and the competition-stability view). Degryse, Elahi and Penas

(2010) use similar methodology to provide evidence in support of the competition-stability view for banking systems at regional level.

Bikker and Haaf (2000) discuss 15 different measures of concentration and their relationship. The most widely used measures remain k banks concentration ratio (CR_k) and Herfindahl-Hirchman index (HHI). The k bank concentration ratio is a discrete measures, which are simple and requires limited data. Supporters of discrete measures maintain the view that the behavior of a market that is dominated by a small number of large-sized banks is very unlikely to be influenced by the small-sized in the market; therefore, the calculation of concentration indices on the basis of the entire bank size distribution would be unnecessarily large-scale, while only marginally changing the final results. Critics adhere to the view that every bank in the market influences market behavior and stress a severe disadvantage of discrete indexes: they ignore the structural changes in those parts of the industry which are not encompassed by the index of concentration. On the other hand, HHI accounts for all banks according to their market share and thus explains the entire size distribution of banks. Such measures stress that structural changes in all parts of the distribution influence the value of the concentration index.

In our analysis, we mainly focuses on the cross-regional contagion that is often transmit through large financial institutions. Small financial institutions neither have reach nor expertise to extend international operations. Therefore, banks' concentration ratio better serves our purpose; however, we use HHI as a robustness check. We find that the results from HHI are very similar to C5 measure of concentration. The estimates are shown in model 4 of table 5.5. For banking industry, we find similar result to Degryse, Elahi and Penas (2010) that a higher level of concentration significantly increases the probability of financial fragility in banking industry in both Asia and Latin America; however, the level of concentration does not have any significant impact of financial fragility of financial services industry in either region. The 1 standard deviation increase in concentration would increase the probability of banking system fragility by 0.612% and 1.444% in Asia and Latin America respectively. Moreover, in line with Degryse, Elahi and Penas (2010), we find that the impact of concentration is higher in Latin America than in Asia.

5.4.2.4 Banking System Capitalization

Finally, we explore how banking system capitalization affects regional fragility of banking system and financial services institutions. Our measure of capital is the region-wide total equity that includes common shares and premium; retained earnings; reserves for general banking risks and statutory reserves; loss absorbing minority interests; net revaluation of AFS securities; FX reserves included in equity and revaluations other than securities deemed to be equity capital. We find that an increase in capitalization would reduce banking system fragility in both regions and financial fragility of financial services in Latin America only. Degryse, Elahi and Penas (2010) assert that greater capital though significantly reduces the probability of banking system fragility in Asia and Latin America, but the economic magnitude is higher in Latin America. We find a similar results that 1 standard deviation increase in capitalization would reduce the probability of regional fragility of banking system by 0.360% and 1.430% in Asia and Latin America respectively; whereas the same increase in capitalization would reduce the probability of regional fragility of financial services industry by 1.232% in Latin America only. Here also, our findings are in line with Degryse, Elahi and Penas (2010) that the impact of capitalization on regional fragility is higher in Latin America than in Asia.

5.4.2.5 Summary

In summary, we find that the increase in liquidity reduce the regional fragility of both banking system and financial services institutions in Asia; whereas, in Latin America, the increase in liquidity decreases the regional fragility of banking systems only. The increase in capitalization significantly reduces the probability of financial fragility of banking system in Asia; whereas, it reduces the probability of financial fragility of both banking and financial services in Latin America. Our findings are supportive of the competition-stability view that increase in competition would significantly reduce the probability of banking system fragility; however, it is not significant for financial fragility of financial services institution in both Asia and Latin America. We also find that focus on traditional loan making activities increase the likelihood of regional banking system fragility in Latin America only. Lastly, we also observe that regional fragility of banking systems is reduced with the increase in liquidity and capitalization and is increased with the increase in concentration but diversification fails to affect banking system fragility in Asia. In Latin America, an increase in liquidity and capitalization would reduce banking system fragility; whereas, an increase in concentration and diversification would

increase banking system fragility. The regional fragility of financial services is reduced by increase in liquidity in Asia and by capitalization in Latin America. Other factors do not have any significant effect on regional fragility of financial services in these regions.

5.4.3 Coexceedance response curves of the common factors and banking system characteristics

The Coexceedance response curves provide a complete picture of the effect of changes in independent variables on the probability of coexceedances. These curves are important because probabilities are not linear functions of the regressors. We plot the probability of coexceedances as a function of the common factor and banking system characteristic at the entire range. The different areas of the plot correspond to different coexceedances levels. Figure 5.6(a) and 5.6(b) provide coexceedances response curves of the common factors and banking system characteristics respectively.

<please insert figure 5.6 here>

We find that the curves are highly nonlinear that support the use of a multinomial logistic model. At low level of conditional volatility, there is high probability of no coexceedances in either industry. The economic magnitude of the increase in conditional volatility on banking system fragility is higher in Asia than in Latin America. On the other hand, the exchange rate changes and interest rate level has higher impact on banking system characteristics in Latin America than in Asia. Among the banking system characteristics we find that aggregate liquidity will reduce the probability of all coexceedances in the entire range in Asia and Latin America. We observe a flat curve for the effect of banking system diversification in Asia; whereas in Latin America, it will significantly reduce the probability of no coexceedances.

5.4.4 Intra-industry and inter-industry cross-regional contagion

We also evaluate intra-industry and inter-industry cross-regional contagion after controlling for common variables. Intra-industry contagion exists when financial fragility in one industry affects the probability of financial fragility in same the industry; whereas, inter-industry contagion refers to the phenomenon when financial fragility in one industry affects the probability of financial fragility in other industry. In order to evaluate cross-regional contagion we introduce a binary

variable for each industry in other regions as explanatory variable in separate models. For example, we have a binary variable for banking industry in Latin America, whose value is 1 when banking system in Latin America is fragile (i.e. 2 or more coexceedances of banking indices in Latin America on that day) otherwise the value is zero. We can call this variable a 'trigger' that reflect fragility in an industry for each region. We have 4 triggers from each region: 1) there are 2 or more coexceedances in either banking or financial services indices 2) there are 2 or more coexceedances in banking only 3) there are 2 or more coexceedances in financial services only 4) there are 2 or more coexceedances in both banking and financial services industry simultaneously. From each triggering region, we use 1 trigger at a time to evaluate the impact of the financial fragility of that industry on banking, financial services and 'both industries together' in the host region. Therefore, we have three marginal effects for each trigger in one regression beside control variables.

<please insert table 5.6 here>

In Table 5.6, we report the impact of cross-regional intra-industry and inter-industry contagion in Asia and Latin America. The first column shows the impact on banking system only, the second column presents the effect on financial services only and the third column illustrates the effect on both industries simultaneously. The intra-industry cross-regional contagion is marked with shaded area. In general, after controlling for the effect of common factors and banking system characteristics, we find that the 2 or more coexceedances in either banking or financial services indices from all regions would significantly increase the probability of financial fragility of banking and financial services industries. Banks are more prone to receive cross-regional as compared to financial services institutions. Intra-industry contagion is more prominent in banking institutions than in financial services institutions. Cross-regional contagion is higher in Asia than in Latin America. Banks from all regions tend to affect banking systems in both Asia and Latin America. Financial services in Latin America are completely immune to any shock from Asia. Banks do not affect financial services industry in other regions; the only exception is the European banking system that affects financial services industry in Asia. In Asia, the economic magnitude of inter-industry contagion from financial services indices is the maximum when it is triggered from Europe. Whereas in Latin America, the inter-industry contagion effect from financial services indices though the maximum when it is triggered from the US, but it is

slightly lower when the contagion is triggered from Europe. However, in general, the cross-regional effect from Europe is more dominant than the US.[24]

More specifically, the banking institutions dominate financial systems in all major economies; therefore, the economic magnitude of inter-industry cross-regional contagion effect that triggers through banking system is higher than financial services industry. For example, in Asia, 2 or more coexceedances in banking indices in Europe would increase the probability of fragility of financial services by 5.5%. Whereas, 2 or more coexceedances in financial services indices in Latin America, the US and Europe would increase the probability of fragility of banking system by 2.6%, 0.6% and 5.9% respectively. In Latin America, we find that the inter-industry cross-regional contagion effect when 2 or more coexceedances in financial services indices in the US and Europe would significantly reduce the probability of banking system fragility by 7.6% and 7.2% respectively.

We also explore the effect of the same trigger from all triggering regions simultaneously in one model but do not report results for the sake of brevity; however, we find that the results are robust.

5.5 CONCLUSION

This chapter investigates the effect of common macro factors (conditional volatility, exchange rate changes and interest rate level) and banking system characteristics (liquidity, diversification, concentration and capitalization) on financial fragility. We also explore the intra-industry and inter-industry contagion among banking and financial services industries. We refer Intra-industry contagion when financial fragility in one industry affects the probability of fragility of the same industry; whereas, inter-industry contagion exists when financial fragility in one industry affects the probability of fragility in other industry. We use stock prices of banking institutions and financial services institutions at regional level in order to assess fragility in banking and financial services industries. The negative coexceedances in financial services are highly correlated with the coexceedances in banking services indices, which motivates the investigation of inter-industry contagion.

[24] In order to check that the inter industry effect we find is something particular within the finance sector; we have done a similar exercise with banking indices and the food sector indices (instead of the financial services sector indices). We find that inter-industry cross-regional contagion is not significant in this case. We do not report these regressions for the sake of brevity.

We find that an increase in regional conditional stock market volatility, a fall in currencies and a rise in interest rate levels significantly increase financial fragility in both banking and financial services industries in Asia. In Latin America, conditional volatility affects both industries but exchange rate depreciation and interest rate level affect only the banking system. This is in line with our expectation that interest rate and exchange rate would have higher implications for the banking system than financial services institutions. In terms of economic significance, we find that exchange rate depreciation has the highest impact in Asia and Latin America. Among banking system characteristics, we find that the increase in liquidity reduce the regional fragility of both banking system and financial services institutions in Asia; whereas, in Latin America, the increase in liquidity decreases the regional fragility of banking systems only. The increase in capitalization significantly reduces the probability of financial fragility of banking system in Asia; whereas, it reduces the probability of financial fragility of both banking and financial services in Latin America. We also find that a focus on traditional loan making activities increase the likelihood of regional banking system fragility in Latin America only. We find that the cross-regional intra-industry contagion is more prominent in banking institutions than in financial services institutions. Banks are more prone to receive cross-regional contagion. Cross-regional contagion is higher in Asia than in Latin America. In Asia, the economic magnitude of inter-industry contagion from financial services indices is highest when it is triggered from Europe. In Latin America, the inter-industry contagion effect from financial services indices is highest when it is triggered from the US, but is only slightly lower when the contagion is triggered from Europe. However, in general, the cross-regional effect from Europe is more dominant than the cross-regional effect from the US.

Table 5.1: Summary Statistics of Daily Returns on Financial Services Indices for a Period from Jul 01, 1994 to Dec 31, 2008

	CHN	KOR	PHL	TWN	INA	IND	MAL	PAK	SRI	THA	ARG	BRA	CHI	COL	MEX	PER	VEN	USA	EUR
No. of Institutions	16	85	34	41	66	33	20	20	17	34	2	23	29	13	8	19	10	45	204
Mean (%)	0.155	0.121	0.123	0.029	0.108	0.174	0.070	0.202	0.094	0.069	0.022	0.145	0.080	0.079	0.028	0.045	0.139	0.044	0.034
Std. Dev. (%)	2.911	2.841	1.988	1.934	1.743	2.434	2.162	1.854	1.446	2.763	1.472	2.171	0.897	1.812	0.791	0.728	2.685	1.749	0.988
Median (%)	0.000	0.000	0.000	0.000	0.000	0.000	-0.001	0.000	0.000	-0.028	0.000	0.000	0.004	0.000	0.002	0.004	0.000	0.014	0.051
Minimum (%)	-14.895	-14.175	-12.157	-10.095	-10.990	-25.091	-15.273	-9.688	-13.491	-15.469	-9.166	-19.319	-7.970	-13.793	-16.634	-8.859	-35.706	-15.799	-9.202
Maximum (%)	35.597	24.575	17.939	13.837	14.715	36.581	28.263	26.321	23.644	23.673	10.198	20.414	15.006	17.798	12.772	22.850	35.318	16.717	10.132

Correlations	CHN	KOR	PHL	TWN	INA	IND	MAL	PAK	SRI	THA	ARG	BRA	CHI	COL	MEX	PER	VEN	USA	EUR
CHN	1.000										0.047	0.052	0.050	0.036	0.020	0.025	0.022	0.051	0.047
KOR	0.047	1.000									0.019	0.117	0.054	0.033	0.020	-0.013	-0.018	0.190	0.131
PHL	0.045	0.121	1.000								0.066	0.137	0.086	0.069	0.030	0.005	0.001	0.190	0.148
TWN	0.043	0.224	0.085	1.000							0.033	0.134	0.037	0.044	0.027	0.019	-0.010	0.199	0.140
INA	0.056	0.159	0.090	0.147	1.000						0.019	0.133	0.071	0.071	0.050	0.004	0.026	0.150	0.103
IND	0.024	0.054	0.066	0.056	0.078	1.000					0.009	0.034	-0.004	0.020	0.018	-0.019	-0.034	0.050	0.029
MAL	0.063	0.179	0.145	0.168	0.144	0.125	1.000				0.030	0.079	0.084	0.049	0.010	-0.018	0.035	0.168	0.082
PAK	0.017	0.024	0.012	0.021	0.053	0.030	0.032	1.000			-0.013	-0.006	-0.010	0.017	0.020	0.001	-0.006	-0.015	0.002
SRI	-0.010	0.013	0.032	0.039	0.007	0.017	0.054	-0.006	1.000		0.011	0.015	0.020	0.008	0.019	0.023	0.007	0.049	0.061
THA	0.049	0.193	0.120	0.133	0.113	0.093	0.245	0.058	0.023	1.000	0.030	0.058	0.037	0.035	0.017	-0.007	0.018	0.120	0.080
Asia					**0.077**									**0.030**				**0.115**	**0.083**
ARG	0.016	0.044	0.045	0.035	0.025	0.030	0.067	-0.002	0.028	0.053	1.000								
BRA	0.045	0.101	0.098	0.077	0.104	0.022	0.072	0.018	0.048	0.074	0.148	1.000							
CHI	0.011	0.055	0.055	0.064	0.077	0.028	0.116	-0.004	0.021	0.083	0.082	0.182	1.000						
COL	0.026	0.082	0.061	0.064	0.114	0.028	0.080	0.028	0.013	0.059	0.023	0.124	0.070	1.000					
MEX	0.031	0.035	0.022	0.022	0.045	0.028	0.034	0.028	0.004	0.037	0.046	0.083	0.062	0.034	1.000				
PER	0.031	0.027	0.052	-0.016	0.045	-0.004	-0.008	-0.002	0.000	0.002	0.003	0.057	0.037	-0.001	0.050	1.000			
VEN	-0.004	-0.012	-0.002	0.018	-0.003	0.024	0.021	0.018	-0.005	0.010	0.035	0.014	0.037	0.026	-0.003	0.013	1.000		
Latin America						**0.036**								**0.053**					
United States	-0.012	0.089	0.035	0.054	0.110	0.005	0.031	0.000	0.018	0.070	0.143	0.376	0.158	0.120	0.124	0.058	0.011	1.000	
						0.040								**0.141**					
Europe	0.037	0.208	0.157	0.171	0.244	0.072	0.197	0.013	0.053	0.172	0.088	0.320	0.211	0.221	0.100	0.072	0.011	0.343	1.000
						0.132								**0.146**					

We report data from 10 Asian countries, 7 Latin American countries, the USA and European block. Asian countries include China (CHN), Korea (KOR), Philippines (PHL), Taiwan (TWN), India (INA), Indonesia (IND), Malaysia (MAL), Pakistan (PAK), Sri Lanka (SRI) and Thailand (THA). Whereas, Latin American countries include Argentina (ARG), Brazil (BRA), Chile (CHI), Colombia (COL), Mexico (MEX), Peru (PER) and Venezuela (VEN).We report number of firms offering financial services that are included from each country/region. Summary statistics include mean, standard deviation, median, minimum, maximum and correlations of daily banking index returns as reported in Datastream. The correlations in upper right matrix are between daily returns of Asian countries in day *t* and those of Latin America, the United States and Europe in day *t-1*. Averages of correlations that are presented in **bold,** represents regional correlations of block above and adjacent to the statistics.

Table 5.2: Summary Statistics of (Co-) exceedances for Financial Services Indices from Jul 01, 1994 to Dec 31, 2008

	Number of Negative (co-)exceedances					
	Mean return when >=4	>=4	3	2	1	0
CHN	-1.26%	8	9	43	130	2462
KOR	-7.32%	23	36	58	73	2462
PHL	-5.00%	26	28	59	77	2462
TWN	-4.66%	23	25	68	74	2462
INA	-5.26%	24	31	49	86	2462
IND	-5.31%	13	26	60	91	2462
MAL	-5.80%	30	33	60	67	2462
PAK	-3.68%	6	10	51	123	2462
SRI	-3.20%	12	14	34	130	2462
THA	-6.62%	23	28	56	83	2462
Total	-4.81%	39	80	269	934	2462
ARG	-3.02%	3	8	64	115	2745
BRA	-6.27%	13	21	52	104	2745
CHI	-2.36%	13	24	57	96	2745
COL	-4.74%	9	9	39	133	2745
MEX	-1.78%	13	20	48	109	2745
PER	-2.10%	10	15	39	126	2745
VEN	---	0	5	53	132	2745
Total	-3.38%	14	34	176	815	2745

The dataset consist of 3784 daily returns for financial services institutions from each country. When daily returns are sorted in ascending order, the lowest five percent data points correspond to Negative exceedances and highest five percent are labeled as Positive exceedances. Coexceedance represents the joint occurrences of exceedances across countries by day. A zero exceedance means no country exceed on that day in the whole region. Similarly, any number (1, 2, …n; where n is the total number of countries in the region) of coexceedances can be observed on a given day. We report negative coexceedances i.e. in Asia, there are 2462 days when no country has negative exceedance but it is possible that a number of countries have positive exceedances during those days. We have stratified the number of coexceedances into four groups (1, 2, 3, and >=4). At the bottom of each block, the total number of days is reported for each number of coexceedance. For example, out of 3784 trading days, we have observed 934 days when only 1 country negatively exceeds in Asia. Similarly, we find 269 days when 2 countries coexceeds and 39 days when 4 or more countries coexceeds in Asia. Within each region, we also mention how often a particular country exceeds. For instance, we find that China is the only country on 130 days out of 934 days when 1 country has lowest extreme return. Similarly, there are 8 days out of 39 days when China is among those 4 or more countries that have joint occurrences of negative coexceedances. The first column gives mean returns when 4 or more countries have negative coexceedances. The bottom row 'Total' provide mean return irrespective of what countries are included, whereas numbers

Table 5.3: Summary Statistics of Common Variables from Jul 01, 1994 to Dec 31, 2008

Common Factors	Conditional Volatility		Change in Exchange Rate		Interest Rate Level	
	Mean	Std Dev.	Mean	Std Dev.	Mean	Std Dev.
CHN	0.2929	0.1384	-0.0001	0.0006	0.0434	0.0309
KOR	0.3374	0.1900	0.0002	0.0096	0.0762	0.0368
PHL	0.2197	0.0698	0.0002	0.0056	0.1037	0.0382
TWN	0.2423	0.0697	0.0001	0.0030	0.0394	0.0208
INA	0.2303	0.0862	0.0001	0.0028	0.0839	0.0263
IND	0.2633	0.1118	0.0001	0.0088	0.1336	0.0750
MAL	0.1816	0.1217	0.0001	0.0066	0.0478	0.0222
PAK	0.2663	0.0973	0.0003	0.0044	0.0960	0.0391
SRI	0.1762	0.2088	0.0002	0.0026	0.1332	0.0372
THA	0.2763	0.0936	0.0001	0.0061	0.0919	0.0315
Asia	**0.2119**	**0.0995**	**0.0001**	**0.0023**	**0.0849**	**0.0284**
ARG	0.2474	0.0882	0.0004	0.0167	0.2149	0.2203
BRA	0.2405	0.1014	0.0003	0.0094	0.0107	0.0077
CHI	0.1254	0.0496	0.0001	0.0081	0.0050	0.0021
COL	0.1442	0.0728	0.0003	0.0057	0.1640	0.1033
MEX	0.1938	0.0743	0.0004	0.0097	0.1648	0.1071
PER	0.1843	0.0659	0.0001	0.0034	0.1279	0.0293
VEN	0.3899	0.1997	0.0008	0.0187	0.1753	0.0915
Latin America	**0.2339**	**0.1084**	**0.0004**	**0.0046**	**0.1214**	**0.0486**
United States	**0.1584**	**0.0791**	**0.0000**	**0.0044**	**0.0413**	**0.0172**
Europe	**0.1503**	**0.0766**	**0.0000**	**0.0054**	**0.0443**	**0.0148**

Summary statistics include mean and standard deviation of 3784 daily observations for each country.

Table 5.4: Summary Statistics of Banking Characteristics from 1994 to 2008

Banking System	Liquid Assets/ Total Assets		Asset Diversity		Loan / Total Earning Assets		Concentration (C5)		Capital Ratio	
Characteristics	Mean	Std Dev.	Mean	Std Dev.	Mean	Std Dev.	Mean	Std Dev.	Mean	Std Dev.
CHN	0.1552	0.0503	0.8479	0.1244	0.5381	0.0923	0.8000	0.0835	0.0355	0.0117
KOR	0.3095	0.0394	0.8318	0.0680	0.5841	0.0340	0.4637	0.0640	0.0508	0.0108
PHL	0.2789	0.0991	0.8377	0.0931	0.4318	0.0651	0.5972	0.0486	0.1182	0.0115
TWN	0.1503	0.0583	0.9227	0.0509	0.4920	0.0486	0.4901	0.1102	0.0768	0.0098
INA	0.3063	0.0379	0.8576	0.0742	0.4799	0.0798	0.4952	0.0624	0.0647	0.0062
IND	0.3167	0.1569	0.7847	0.1612	0.5357	0.1325	0.6927	0.0956	0.0791	0.0916
MAL	0.2882	0.0200	0.7979	0.0708	0.6011	0.0354	0.4420	0.0627	0.0882	0.0151
PAK	0.3414	0.0644	0.8553	0.0616	0.4746	0.0766	0.7886	0.1375	0.0616	0.0396
SRI	0.3947	0.0448	0.9135	0.0572	0.5322	0.0414	0.8248	0.1184	0.0774	0.0249
THA	0.2613	0.0408	0.7265	0.0992	0.6367	0.0496	0.6032	0.0655	0.0646	0.0223
Asia	**0.2134**	**0.0370**	**0.9073**	**0.0909**	**0.5396**	**0.0518**	**0.6254**	**0.0425**	**0.0528**	**0.0035**
ARG	0.1901	0.0599	0.7483	0.1527	0.4686	0.1474	0.5929	0.0749	0.1114	0.0128
BRA	0.3975	0.0669	0.7101	0.0640	0.3550	0.0320	0.5446	0.0726	0.0783	0.0067
CHI	0.3067	0.0570	0.7456	0.1052	0.6170	0.0737	0.7464	0.0761	0.0471	0.0130
COL	0.3028	0.1337	0.7803	0.2051	0.5762	0.1312	0.5713	0.0850	0.2009	0.0456
MEX	0.1971	0.0748	0.7389	0.1622	0.6291	0.0835	0.6484	0.1326	0.0867	0.0240
PER	0.2398	0.0955	0.8924	0.0906	0.4720	0.0657	0.8074	0.0467	0.0732	0.0141
VEN	0.3623	0.0819	0.6531	0.1568	0.3623	0.1345	0.7581	0.0846	0.1582	0.0597
Latin America	**0.3244**	**0.0563**	**0.8879**	**0.0624**	**0.4440**	**0.0312**	**0.5928**	**0.0529**	**0.0873**	**0.0089**
United States	**0.3786**	**0.0223**	**0.9488**	**0.0324**	**0.5068**	**0.0303**	**0.1514**	**0.0235**	**0.0701**	**0.0038**
Europe										

Summary statistics include mean and standard deviation of 3784 daily observations for each country

Table 5.5: Multinomial Logistics Regression with Regional Common Factors and Regional Banking System Characteristics

		No. of Coex	Relative Freq	Model 1 Coeff	Model 1 Chg Prob	Model 2 Coeff	Model 2 Chg Prob	Model 3 Coeff	Model 3 Chg Prob	Model 4 Coeff	Model 4 Chg Prob	Model 5 Coeff	Model 5 Chg Prob
ASIA													
Base Case	1	3196	0.8446										
Constant	2	200	0.0529	-6.533 [a]		-2.270 [b]		-5.802 [b]		-8.963 [a]		-5.228 [b]	
	3	209	0.0552	-4.901 [a]		-3.852 [a]		-4.960 [a]		-6.320 [a]		-7.599 [a]	
	4	179	0.0473	-5.880 [a]		-3.633 [a]		-5.554 [a]		-7.809 [a]		-8.341 [a]	
Cond. Volatility	2			0.065 [a]	0.0023	0.064 [a]	0.0022	0.064 [a]	0.0023	0.065 [a]	0.0022	0.064 [a]	0.0023
	3			0.061 [a]	0.0027	0.059 [a]	0.0026	0.061 [a]	0.0027	0.060 [a]	0.0026	0.061 [a]	0.0026
	4			0.079 [a]	0.0025	0.079 [a]	0.0025	0.079 [a]	0.0025	0.079 [a]	0.0024	0.079 [a]	0.0024
Avg. Chg. ER	2			1.106 [a]	0.0379	1.136 [a]	0.0377	1.112 [a]	0.0383	1.113 [a]	0.0373	1.092 [a]	0.0380
	3			1.022 [a]	0.0433	1.038 [a]	0.0441	1.023 [a]	0.0433	1.020 [a]	0.0430	1.036 [a]	0.0430
	4			2.160 [a]	0.0698	2.179 [a]	0.0697	2.163 [a]	0.0700	2.169 [a]	0.0689	2.188 [a]	0.0689
Avg. Int. Rate Level	2			0.261 [a]	0.0098	0.101 [b]	0.0036	0.267 [a]	0.0101	0.246 [a]	0.0090	0.247 [a]	0.0094
	3			0.096 [a]	0.0039	0.060	0.0026	0.096 [a]	0.0039	0.084 [a]	0.0034	0.110 [a]	0.0045
	4			0.122 [a]	0.0036	0.037	0.0010	0.125 [a]	0.0037	0.105 [a]	0.0030	0.138 [a]	0.0040
Liquidity	2					-14.130 [a]	-0.5150						
	3					-3.444 [b]	-0.1250						
	4					-7.457 [b]	-0.2250						
Diversification	2							-1.693	-0.0655				
	3							0.130	0.0112				
	4							-0.778	-0.0242				
Concentration	2									4.035 [b]	0.1440		
	3									2.431	0.1030		
	4									3.247	0.0984		
Capitalization	2											-21.970 [c]	-1.0310
	3											48.500	2.2620
	4											43.550	1.3870
Log-Likelihood				-1918.1		-1908.9		-1917.9		-1914.5		-1914.8	
Pseudo-R^2				0.11		0.12		0.11		0.11		0.11	
LATIN AMERICA													
Base Case	1	3406	0.9001										
Constant	2	154	0.0407	-5.486 [a]		-2.729 [a]		-8.547 [a]		-10.740 [a]		0.181	
	3	145	0.0383	-4.077 [a]		-2.089 [c]		-4.505 [a]		-3.978 [a]		0.718	
	4	79	0.0209	-6.718 [a]		-8.626 [a]		-4.326		-3.605		-7.283 [a]	
Cond. Volatility	2			0.045 [a]	0.0013	0.052 [a]	0.0014	0.048 [a]	0.0014	0.054 [a]	0.0015	0.049 [a]	0.0013
	3			0.037 [a]	0.0011	0.041 [a]	0.0012	0.037 [a]	0.0011	0.037 [a]	0.0011	0.040 [a]	0.0012
	4			0.087 [a]	0.0008	0.085 [a]	0.0007	0.085 [a]	0.0007	0.083 [a]	0.0007	0.088 [a]	0.0008
Avg. Chg. ER	2			0.360 [a]	0.0104	0.370 [a]	0.0102	0.364 [a]	0.0102	0.368 [a]	0.0100	0.391 [a]	0.0105
	3			0.282	0.0083	0.297 [c]	0.0087	0.285	0.0084	0.291	0.0086	0.312 [c]	0.0090
	4			0.566 [a]	0.0049	0.580 [a]	0.0049	0.568 [a]	0.0049	0.578 [a]	0.0048	0.586 [a]	0.0051
Avg. Int. Rate Level	2			0.086 [a]	0.0026	0.053 [b]	0.0016	0.074 [a]	0.0022	0.036	0.0010	0.030 [b]	0.0009
	3			-0.013	-0.0005	-0.047	-0.0015	-0.016	-0.0006	-0.012	-0.0004	-0.080	-0.0025
	4			0.004	0.0000	0.030	0.0003	0.019	0.0002	0.043	0.0004	0.009	0.0001
Liquidity	2					-7.993 [a]	-0.2270						
	3					-5.318	-0.1590						
	4					5.079	0.0482						
Diversification	2							6.981 [c]	0.2050				
	3							1.031	0.0272				
	4							-5.680	-0.0531				
Concentration	2									9.545 [a]	0.2730		
	3									-0.195	-0.0135		
	4									-6.052	-0.0544		
Capitalization	2											-58.940 [a]	-1.6020
	3											-46.780 [a]	-1.3800
	4											5.242	0.0755
Log-Likelihood				-1245.2		-1238.9		-1243.1		-1236.3		-1232.9	
Pseudo-R^2				0.1		0.11		0.1		0.11		0.11	

Table 5 shows multinomial regressions with dependent variable is a count variable with four categories i.e. whose value of 1, 2, 3 and 4. The value is 1 when there is neither banking indices nor financial services indices have 2 or more coexceedances in a region. This variable has value 2 when there are 2 or more coexceedances in only the banking services indices. Similarly, the variable gets value 3 when 2 or more coexceedances in only financial services indices. Finally, the value 4 represents that there are 2 or more coexceedances in both banking services and financial services indices. [a, b, c] Denotes significance levels at the 1%, 5% and 10% repectively.

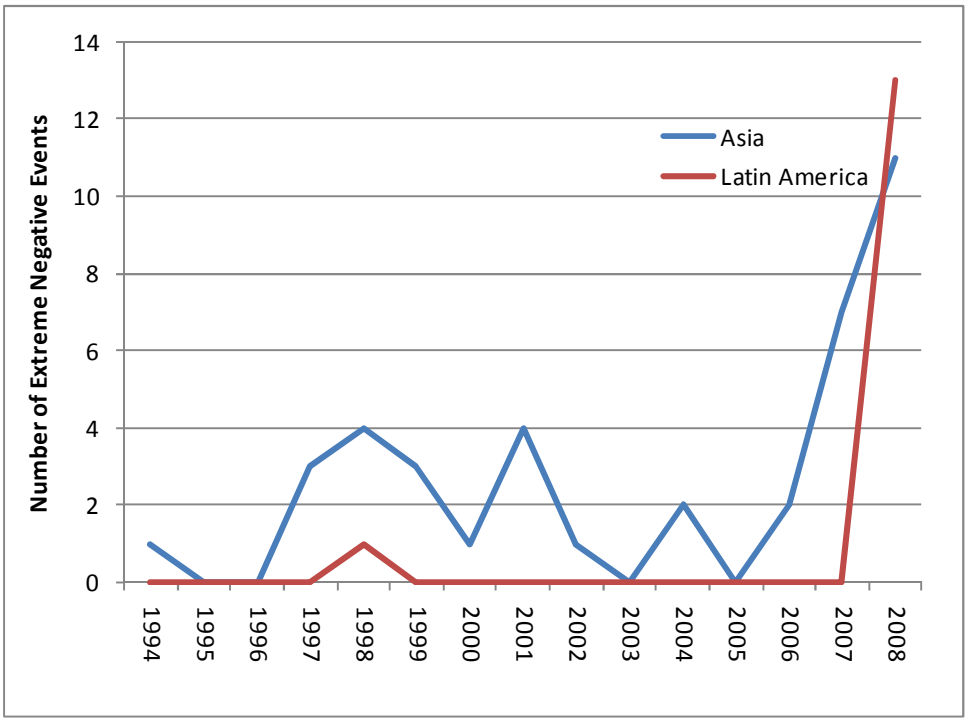
Table 5.6: Inter-Industry and Intra-Industry Cross-Regional Contagion

	Banks		Financial Srv.		Both		Banks		Financial Srv.		Both	
	Coeff	Chg Prob	Coeff	Chg Prob	Coeff	Chg Prob	Coeff	Chg Prob	Coeff	Chg Prob	Coeff	Chg Prob
	ASIA						LATIN AMERICA					
Control for common macro factors	YES		YES		YES		YES		YES		YES	
Control for banking system characteristics	YES		YES		YES		YES		YES		YES	
Trigger (2 or more coexceedances)												
ASIA												
Either Banking or Financial Services Indices							0.699 [a]	0.023	-0.152	-0.005	1.764 [a]	0.022
Banking Index only							0.770 [a]	0.029	-0.201	-0.006	1.641 [a]	0.026
Financial Services Index only							-0.392	-0.010	0.202	0.007	0.194	0.002
Both Banking and Financial Services indices							0.918 [a]	0.037	-0.390	-0.010	1.314 [a]	0.019
LATIN AMERICA												
Either Banking or Financial Services Indices	0.989 [a]	0.047	0.619 [a]	0.028	1.195 [a]	0.052						
Banking Index only	0.673 [b]	0.029	0.449	0.019	1.077 [a]	0.050						
Financial Services Index only	0.587 [c]	0.026	0.644 [b]	0.038	0.133	0.002						
Both Banking and Financial Services indices	1.548 [a]	0.098	0.668	0.023	1.701 [a]	0.099						
United States												
Either Banking or Financial Services Indices	0.900 [a]	0.040	0.224 [a]	0.003	1.692 [a]	0.095	1.557 [a]	0.071	1.229 [a]	0.045	2.242 [a]	0.041
Banking Index only	0.480 [a]	0.022	-0.720	-0.026	0.722 [c]	0.032	0.779 [a]	0.029	0.456	0.013	1.236 [c]	0.018
Financial Services Index only	0.340	0.006	0.901 [b]	0.050	1.688 [a]	0.112	1.364 [a]	0.076	0.510	0.016	-0.293	-0.003
Both Banking and Financial Services indices	1.124 [a]	0.057	0.268	0.003	1.714 [a]	0.103	1.675 [a]	0.082	1.557 [a]	0.068	2.614 [a]	0.062
Europe												
Either Banking or Financial Services Indices	1.248 [a]	0.061	0.798 [a]	0.034	1.855 [a]	0.103	1.515 [a]	0.066	1.414 [a]	0.056	2.551 [a]	0.048
Banking Index only	0.444 [a]	0.015	0.890 [b]	0.055	0.886 [b]	0.037	0.717 [a]	0.027	0.186	0.004	0.991 [c]	0.013
Financial Services Index only	1.114 [a]	0.059	0.535 [a]	0.020	1.437 [a]	0.082	1.462 [a]	0.072	1.857 [a]	0.123	-0.421	-0.004
Both Banking and Financial Services indices	1.448 [a]	0.079	0.738 [b]	0.026	2.054 [a]	0.134	1.510 [a]	0.069	1.215 [a]	0.044	2.999 [a]	0.085

[a, b, c] Denotes significance levels at the 1%, 5% and 10% repectively.

Table 5.6 reports the potential of cross-regional intra-industry and inter-industry contagion in Asia and Latin America. The first column shows the impact on banking system, the second column presents the effect on financial services and the third column illustrates the effect on both industries simultaneously. We investigate four cases from each triggering region: 1) there are 2 or more coexceedances in either banking or financial services indices 2) there are 2 or more coexceedances in banking only 3) there are 2 or more coexceedances in financial services only 4) there are 2 or more coexceedances in both banking and financial

Figure 5.1: Clustering of Negative Extreme Events in Financial Services Indices



We define negative extreme event when 4 or more countries have lowest 5 percent returns. Out of total 3784 trading days, we observe 39 and 14 extreme events in Asia and Latin America respectively. On y-axis, we measure the number of extreme events during each year in our sample period.

Figure 5.2: Interdependence of Banking and Financial Services Indices

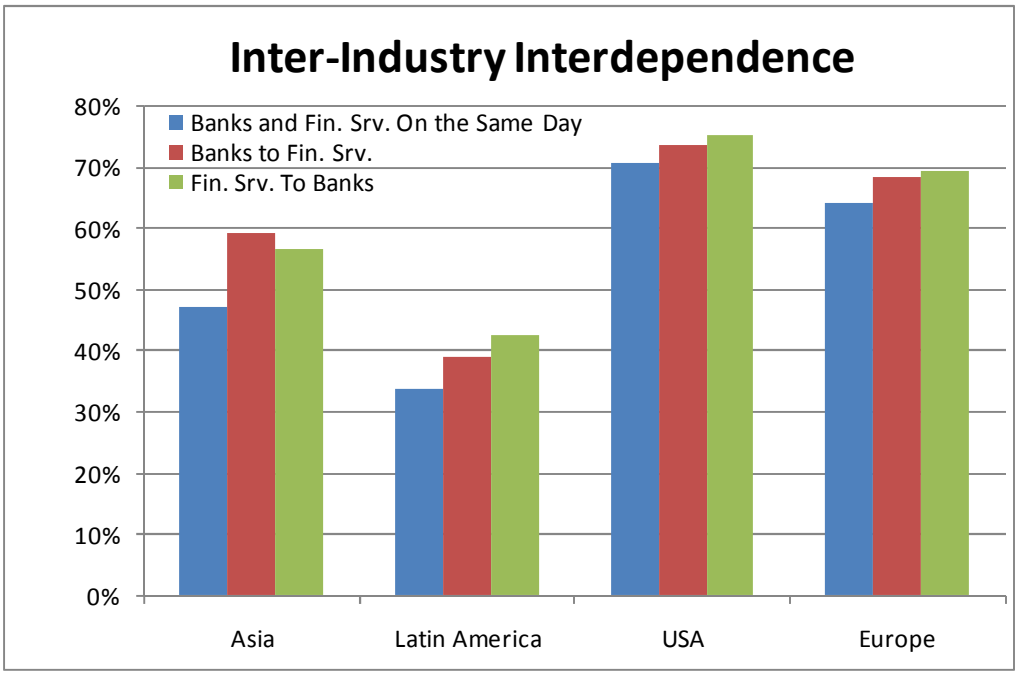
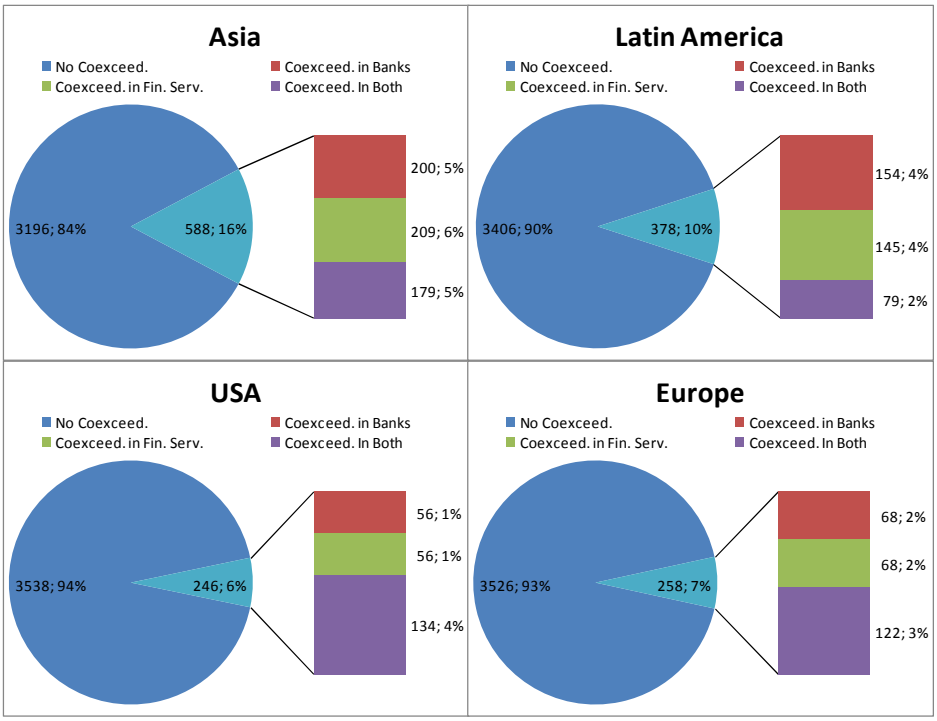


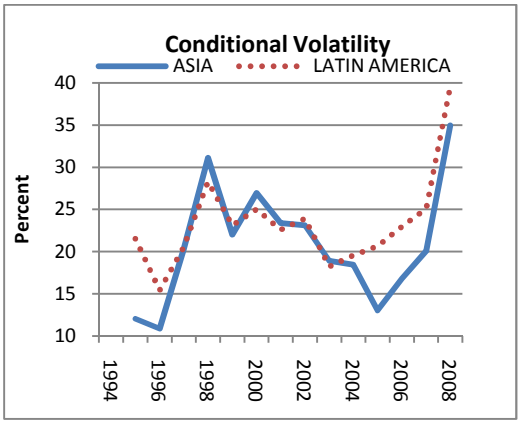
Figure 5.2 reports how often the coexceedances in banking indices are matched with coexceedances in financial services indices in the four regions. Blue columns represent the percentage of matched coexceedances against coexceedances in banking indices on the same day. Whereas red columns show the percentage of coexceedances in banking indices that are matched with coexceedances in financial services indices on the same day and the following day.

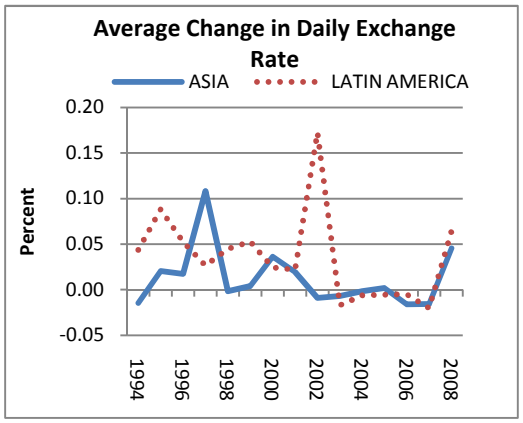
Figure 5.3: Extreme Negative Returns in Banking and Financial Services Indices

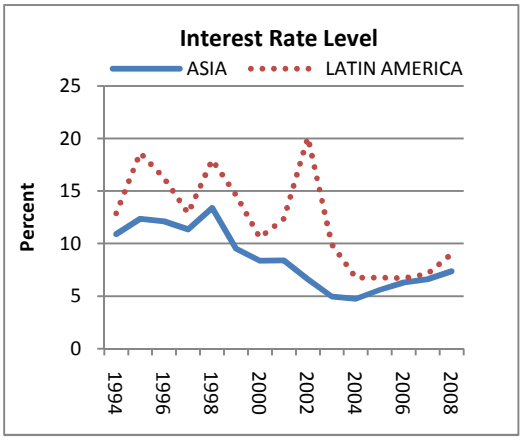


The dark blue area represent the number of days in the whole sample when there is no extreme negative return in any of the banking and financial services industry. The column on the right shows the number of days when banking industry or financial services industry or both have 2 or more joint extreme negative return in the region.

Figure 5.4: Trend in Common Macroeconomic Factors

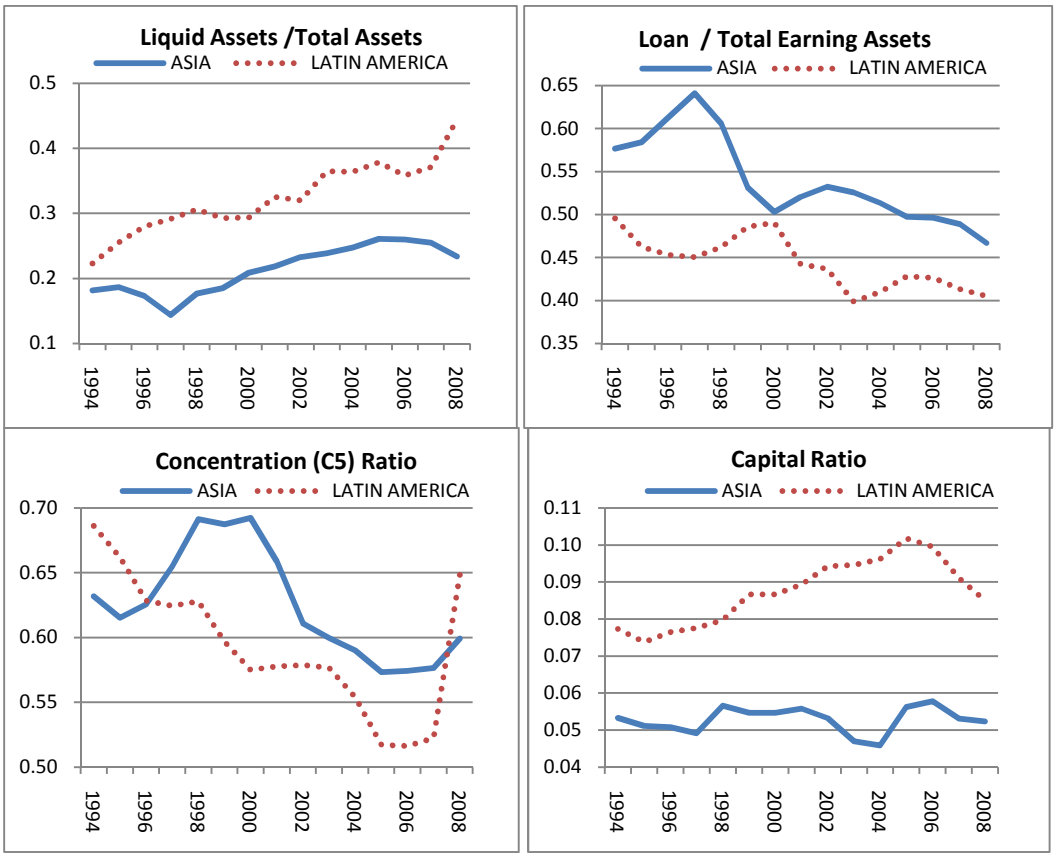






The regional common factor is the simple average of all countries in the region. We calculate these factors for each trading day in our sample.

Figure 5.5: Trend in Banking Characteristics



The regional banking system characteristics are weighted average of individual countries in the region using total assets of the banking system as weights.

Figure 5.6(a): Coexceedances Response Curves for Common Macro Factors

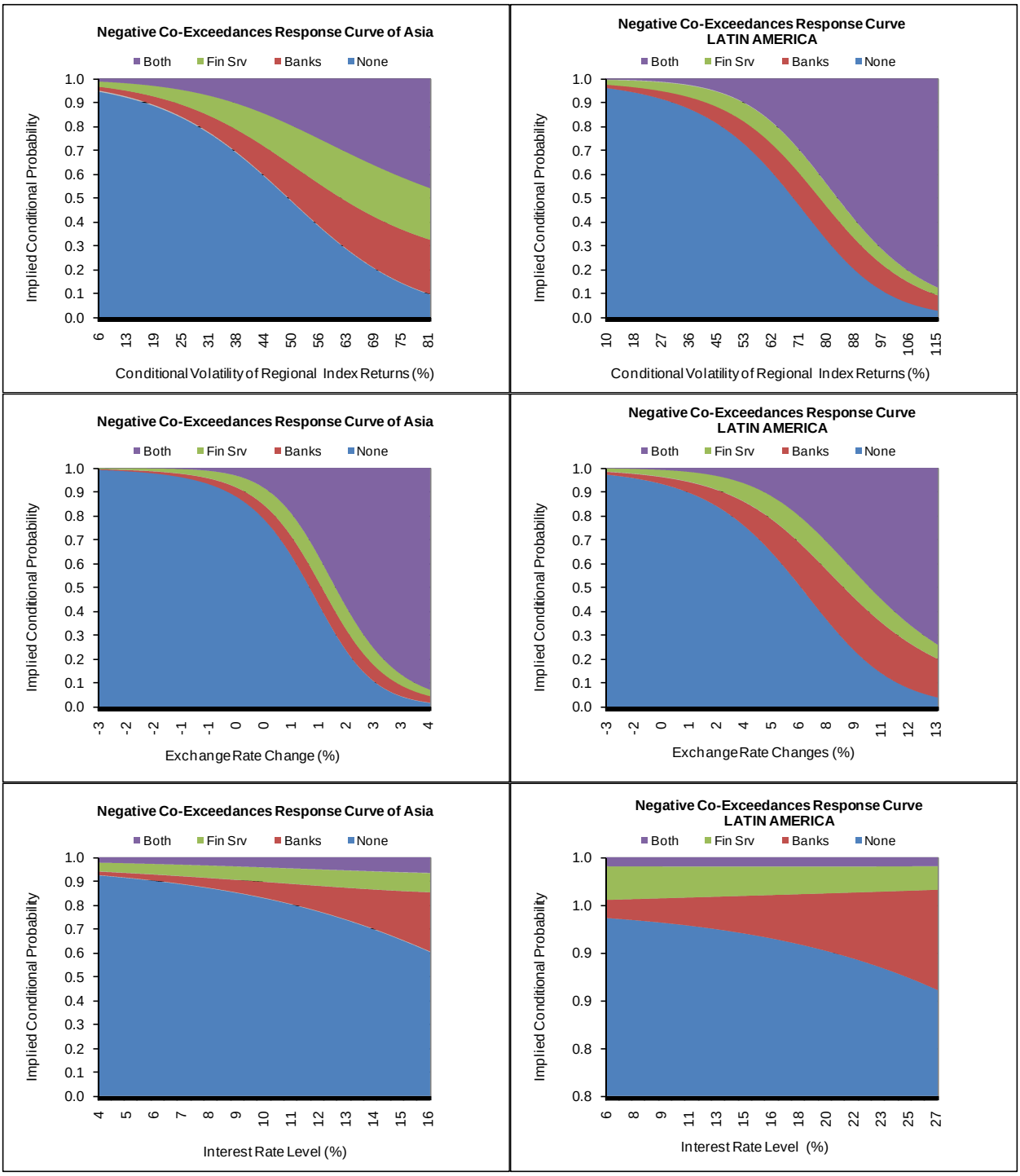
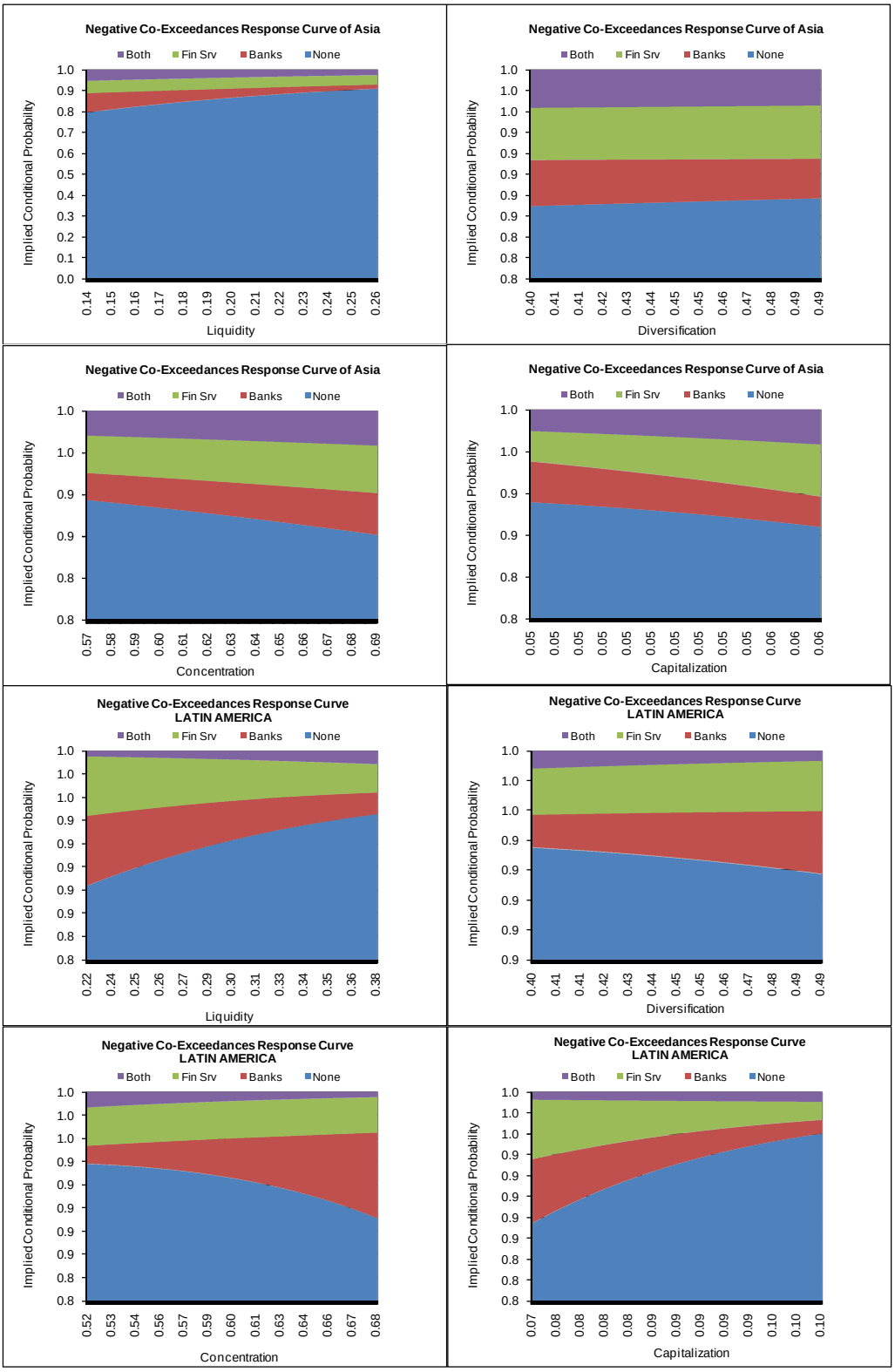


Figure 5.6(b): Coexceedances Response Curves for Banking System Characteristics



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Appendix 1

Ai and Norton (2003) provide a correct way to estimate the magnitude and standard errors of interaction effects in non-linear models as follows:

Let *y* denote the raw dependent variable for a general non-linear model. Let the vector $\boldsymbol{x}$ be a $k \times 1$ vector of independent variables, so $\boldsymbol{x}' = (x_1, x_2, x_3 \cdots x_k)$**.** The expected value of *y* given *x* is

$$E[y|\boldsymbol{x}] = F(x, \beta)$$

where the function *F* is known up to β and is twice continuously differentiable. Let Δ denote either the difference or the derivative operator, depending on whether the regressors are discrete or continuous. The interaction effect of x_1 and x_2 on *y* is the cross derivatives (or differences) given by

$$\mu_{12} = \frac{\Delta^2 F(x, \beta)}{\Delta x_1 \Delta x_2}$$

and the estimated value of interaction effect is

$$\acute{\mu}_{12} = \frac{\Delta^2 F(x, \acute{\beta})}{\Delta x_1 \Delta x_2}$$

where $\acute{\beta}$ is a consistent estimator of β. The continuity of F and consistency of $\acute{\beta}$ ensures the consistency of $\acute{\mu}_{12}$ to μ_{12}. They also provide standard error and asymptotic variance of the estimated interaction effect $\acute{\mu}_{12}$. Moreover, they argue that the magnitude and statistical significance of the interaction effect varies by observation. It can even change sign for variant observations of the same independent variables; therefore, it is advised to draw graphs for relevant inference. The graphs in the text are drawn using their methodology. The continuous concave line is the marginal effect of the interaction term computed by standard procedure; whereas, dots show the correct interaction effect. The statistical significance of the interaction effect is shown in adjacent graph, i.e. whenever the z-value lies above or below the confidence interval lines shows significant of the interaction effect.

Appendix 2

Consolidated foreign claims of reporting banks - immediate borrower basis
On individual countries by nationality of reporting banks / Amounts outstanding
In millions of US dollars

	Jun.1994	Jun.1995	Jun.1996	Jun.1997	Jun.1998	Jun.1999	Jun.2000	Jun.2001	Jun.2002	Jun.2003	Jun.2004	Jun.2005	Jun.2006	Jun.2007	Jun.2008
EUROPE															
All countries	790731	923557	1060306	1286411	1429315	5968119	6529632	6965324	8139558	10074284	11765896	14456466	16793137	21952861	25085466
Developed countries	90065	110529	125823	151531	190415	4750731	5276802	5617721	6710670	8492067	9875734	12051088	13916823	17994403	19958070
Europe	40304	52222	61289	64836	85094	3057116	3293750	3461620	4203006	5286346	6193284	7684411	8864463	11860538	13754119
United States	...	...	...	...	...	1227024	1454298	1668156	1955626	2517742	2865744	3493894	4087123	4966754	4767750
Asia & Pacific	90359	123419	160045	200455	184934	191624	190345	173752	192807	224247	276762	365213	470779	658289	817780
	11,43%	**13,36%**	**15,09%**	**15,58%**	**12,94%**	**3,21%**	**2,92%**	**2,49%**	**2,37%**	**2,23%**	**2,35%**	**2,53%**	**2,80%**	**3,00%**	**3,26%**
China	15737	20222	25458	30122	32592	29407	28314	25694	27258	30819	38847	45031	73237	124189	160067
Chinese Taipei	12467	17063	16803	17687	16878	15132	18499	14391	18755	24930	41363	41216	46876	66682	78254
Philippines	2218	3165	5267	9436	11537	10272	10853	9940	11418	12263	14217	14704	16111	17439	17428
South Korea	14993	22615	30448	41550	31505	31086	32105	30353	37889	47001	54785	114970	154669	192325	227272
India	6800	10625	11345	13721	14536	19706	20031	21286	21116	28221	37898	42912	58560	87388	126698
Indonesia	9520	14347	20177	25566	22397	23789	23834	20096	20146	22221	20933	23939	25726	35050	35824
Malaysia	5495	6330	8485	15285	12257	10467	21526	20973	22067	24715	28296	38620	41115	49868	59827
Pakistan	1751	2912	3457	3685	3934	4211	4402	4452	4807	3904	3787	3745	4513	11025	11460
Sri Lanka	408	635	701	701	659	1214	1280	1562	1312	1436	1684	2049	2525	3013	4217
Thailand	9001	12425	21205	23650	17086	18570	20079	15999	17103	15632	16427	14134	16019	19034	20582
Latin America/Caribbea	106753	119691	140153	197914	264981	264721	296137	347573	303090	297042	309482	378260	430062	559243	733860
	13,50%	**12,96%**	**13,22%**	**15,38%**	**18,54%**	**4,44%**	**4,54%**	**4,99%**	**3,72%**	**2,95%**	**2,63%**	**2,62%**	**2,56%**	**2,55%**	**2,93%**
Argentina	18161	22480	23350	32563	47805	53623	56992	55119	26988	26552	24373	21090	21437	26901	29197
Brazil	31283	32673	41584	64258	95129	76065	85357	92774	80610	67733	72854	105834	132999	199972	297520
Chile	6873	8687	11280	15714	19532	32657	31903	32204	30574	30880	33304	39129	46966	53272	70419
Colombia	4352	5511	6821	11334	14150	12566	11077	10636	9797	7976	7903	9078	10846	17061	17982
Mexico	25316	26204	30654	44550	48775	48963	68145	113201	115427	127581	132119	158255	170523	202873	242836
Peru	1986	3781	6170	6897	8863	9134	12431	12906	11578	10599	10379	11021	7770	9530	15569
Venezuela	8339	7098	6802	10919	13036	12339	14720	16187	13832	13383	14747	17756	21118	25343	27037
USA															
All countries	191920	206579	243407	308914	310586	659730	709522	778682	799446	788623	972818	1026596	1275295	1720241	1722788
Developed countries	24674	27758	32232	36725	36782	387525	429602	496449	491283	512541	637850	642364	813630	1107930	1037229
Europe	6035	5989	6306	8342	8747	287411	327976	351078	366016	382631	492382	497823	642079	842522	773421
United States	...	...	...	...	...	...	-	-	-	-	...	-	...	...	...
Asia & Pacific	40191	47397	59340	74794	60053	62764	66003	63860	74674	68343	117725	131867	148940	208050	221295
China	656	1176	2251	3592	2932	3535	2979	4790	6298	4670	6861	11199	17660	29766	30565
Chinese Taipei	7022	9273	9889	11799	10659	11072	11707	11569	16690	15471	19601	19431	16287	16130	26848
India	3863	4049	4427	5483	5273	5997	6508	7289	7633	10392	13759	17866	22924	44351	43171
Indonesia	3232	3413	5071	6992	4425	5394	5039	3763	3016	2951	2637	3243	4360	8368	8534
Malaysia	5503	4978	6140	7622	4942	6462	7281	7482	7997	8243	10490	11804	11340	13511	14047
Pakistan	1680	1706	2123	2443	2237	1634	1180	1030	1035	1108	1153	1204	1843	2077	1603
Philippines	3255	3807	5335	7115	5800	5832	5491	4764	4972	4457	4682	4278	4288	4916	5175
South Korea	9070	12537	14466	16712	14319	14468	17998	16089	20961	15413	52858	56035	59735	72993	71951
Sri Lanka	193	55	38	60	84	90	105	108	151	208	203	220	269	366	327
Thailand	4751	5739	7549	9814	6031	4896	4525	4131	4122	3952	4143	4878	7782	5688	5391
Latin America/Caribbea	71340	72621	83871	98149	110498	110003	106583	110933	127028	112433	105695	123804	133052	156386	182150
Argentina	11936	13450	15373	18830	24202	26533	26562	23122	10389	7888	5626	5732	6448	6822	7122
Brazil	18588	17726	28321	30280	34118	26714	28890	33425	29161	21492	22371	26667	27785	36077	47413
Chile	6938	8934	8925	10649	11461	8696	8054	7648	6738	7226	7226	8832	9141	7436	6464
Colombia	2779	3333	3684	5040	5391	5053	3965	4104	3589	2476	2200	2766	3893	7180	6527
Mexico	22143	20867	18566	21765	20165	26493	23403	27262	63209	61121	57850	68292	76046	80493	94028
Peru	494	573	939	1592	2845	2937	2504	2401	1976	1720	1656	1357	1292	2590	3722
Venezuela	5108	3790	3039	3590	4212	4032	3973	3557	2517	2317	1896	2007	1820	2566	2494

Appendix 3

Industry Classification Benchmark (ICB) for financial services industry

8700 Financial Services	8770 Financial Services	8771 Asset Managers	Companies that provide custodial, trustee and other related fiduciary services. Includes mutual fund management companies.
		8773 Consumer Finance	Credit card companies and providers of personal finance services such as personal loans and check cashing companies.
		8775 Specialty Finance	Companies engaged in financial activities not specified elsewhere. Includes companies not classified under Equity Investment Instruments or Non-equity Investment Instruments engaged primarily in owning stakes in a diversified range of companies.
		8777 Investment Services	Companies providing a range of specialized financial services, including securities brokers and dealers, online brokers and security or commodity exchanges.
		8779 Mortgage Finance	Companies that provide mortgages, mortgage insurance and other related services.
	8980 Equity Investment Instruments	8985 Equity Investment Instruments	Corporate closed-ended investment entities identified under distinguishing legislation, such as investment trusts and venture capital trusts.
	8990 Non-equity Investment Instruments	8995 Non-equity Investment Instruments	Non corporate, open-ended investment instruments such as open-ended investment companies and funds, unit trusts, ETFs, currency funds and split capital trusts.

Appendix 4

Total Export of all commodities to regional countries in Latin America — Million USD

2008	Argentina	Brazil	Chile	Colombia	Mexico	Peru	Venezuela
Argentina	---	13,273	4,714	810	1,337	1,313	1,420
Brazil	17,606	---	4,792	2,295	4,281	2,299	5,150
Chile	983	3,849	---	705	2,210	1,297	1,210
Colombia	649	133	849	---	617	855	6,092
Mexico	3,367	1,315	1,587	3,032	---	1,180	2,310
Peru	895	147	1,841	709	299	---	1,079
Venezuela	1,808	12	1,167	930	284	95	---
2004							
Argentina	---	34,576	5,412	3,831	273	1,032	498
Brazil	96,677	---	7,391	2,556	1,044	3,958	636
Chile	32,520	425	---	1,421	308	1,307	499
Colombia	16,730	36	141	---	254	525	544
Mexico	187,980	417	573	555	---	624	179
Peru	12,726	36	358	719	262	---	229
Venezuela	39,887	19	560	344	1,042	441	---
2000							
Argentina	---	26,341	6,991	2,674	131	326	295
Brazil	55,119	---	6,238	1,248	516	1,713	354
Chile	18,215	639	---	969	236	816	439
Colombia	13,158	56	284	---	191	230	373
Mexico	166,294	337	689	545	---	500	210
Peru	6,866	26	221	263	144	---	151
Venezuela	30,948	23	1,129	149	853	275	---
1996							
Argentina	---	23,810	6,615	1,766	183	248	254
Brazil	47,746	---	5,170	1,055	432	679	298
Chile	15,407	700	---	947	194	146	325
Colombia	10,648	52	119	---	182	89	613
Mexico	95,661	536	974	756	---	467	228
Peru	5,835	38	239	123	120	---	96
Venezuela	23,072	64	747	206	1,250	151	---

Source: UN Contrade Database

Total Export of all commodities to regional countries in Asia — Million USD

2008	China	Korea	Philippines	Taiwan	India	Indonesia	Malaysia	Pakistan	Sri Lanka	Thailand
China	---	73,932	9,132	2,602	31,585	17,193	21,455	6,051	1,630	15,636
Korea	91,389	---	5,016	24	8,977	7,934	5,794	840	627	5,779
Philippines	5,469	2,523	---	8	194	603	1,958	44	9	1,509
Taiwan	245	2	16	---	0	1	4	0	0	2
India	10,094	3,773	755	6	---	2,659	3,034	1,773	2,838	2,005
Indonesia	11,637	9,117	2,054	5	7,163	---	6,433	930	354	3,661
Malaysia	18,945	7,759	2,925	15	7,413	6,215	---	1,719	424	9,512
Pakistan	727	208	115	0	355	63	138	---	217	88
Sri Lanka	48	35	3	1	418	40	46	71	---	78
Thailand	15,998	3,639	3,462	28	3,369	6,253	9,783	637	342	---
2004										
China	---	27,812	4,269	1,618	5,936	6,256	8,086	2,466	695	5,802
Korea	49,763	---	3,379	36	3,632	3,678	4,480	591	243	3,249
Philippines	2,653	1,113	---	3	89	376	2,070	20	8	1,064
Taiwan	391	4	12	---	0	0	7	0	0	5
India	4,099	970	363	2	---	1,206	1,040	522	1,400	857
Indonesia	4,605	4,830	1,238	8	2,171	---	3,016	416	238	1,976
Malaysia	8,496	4,460	1,943	6	3,015	3,063	---	702	346	6,026
Pakistan	301	182	29	0	158	57	66	---	135	61
Sri Lanka	17	18	3	1	385	8	9	39	---	18
Thailand	7,098	1,851	1,829	5	912	3,210	5,297	434	183	---
2000										
China	---	11,292	1,464	710	1,561	3,062	2,565	670	445	2,243
Korea	18,455	---	3,360	54	1,326	3,504	3,515	404	380	2,015
Philippines	663	1,173	---	5	64	183	1,377	8	8	1,206
Taiwan	259	1	2	---	0	0	7	0	0	2
India	735	439	174	1	---	390	531	164	594	525
Indonesia	2,768	4,318	820	3	1,151	---	1,972	149	179	1,026
Malaysia	3,028	3,280	1,726	6	1,924	1,706	---	396	227	3,549
Pakistan	245	264	38	1	65	112	53	---	82	63
Sri Lanka										
Thailand	2,816	1,264	1,080	5	492	1,337	2,805	201	174	---
1996										
China	---	7,500	1,015	573	686	1,428	1,370	623	192	1,255
Korea	11,377	---	1,906	62	1,177	3,198	4,333	358	345	2,664
Philippines	328	371	---	1	37	142	687	18	6	780
Taiwan	264	5	3	---	0	0	2	0	0	2
India	615	518	184	2	---	592	531	157	477	447
Indonesia	2,057	3,281	688	0	531	---	1,110	125	107	823
Malaysia	1,909	2,407	937	7	1,206	1,218	---	645	158	3,203
Pakistan	119	273	51	2	42	139	39	---	83	97
Sri Lanka										
Thailand	1,869	1,013	631	10	243	963	2,015	147	138	---

Source: UN Contrade Database

Appendix 5

List of banks that are included in the indices of different countries

CHINA

Bank of Beijing 'A'
Bank of China 'A'
Bank of Communications 'A'
Bank of Nanjing 'A'
Bank of Ningbo 'A'
China Citic Bank 'A'
China Construction Bank 'A'
China Merchants Bank 'A'
China Minsheng Banking 'A'
Huaxia Bank 'A'
Industrial and Commercial Bank of China 'A'
Industrial Bank 'A'
Shanghai Pudong Development Bank 'A'
Shenzhen Development Bank 'A'

SOUTH KOREA

Cheju Bank
Daegu Bank
Jeil Mutual Savings Bank
Jeonbuk Bank
KB Financial Group
Hana Financial Group
Shinhan Financial Group
Woori Finance Holdings
Industrial Bank of Korea
Jinheung Mutual Savings Bank
Korea Exchange Bank
Korea Mutual Savings Bank
Busan Bank
Pureun Mutual Savings Bank
Seoul Mutual Savings Bank
Shinmin Mutual Savings Bank
Solomon Mutual Savings Bank

PHILIPPINES

Asiatrust Development Bank
Banco de Oro Unibank
Bank of the Philippine Islands
China Banking
Chinatrust (Philippines) Commercial Bank
Citystate Savings
First Metro Investment
Metropolitan Bank and Trust
Philippine National Bank
Philippine Bank of Communications
Philippine Savings Bank
Philtrust Bank
Rizal Commercial Banking
Security Bank
Union Bank of the Philippines

TAIWAN

Bank of Kaohsiung
Cosmos Bank Taiwan
Entie Commercial Bank
Chang Hwa Commercial Bank
Far Eastern International Bank
King's Town Bank
Ta Chong Bank
Taichung Commercial Bank
Taiwan Business Bank
Taiwan Cooperative Bank
Union Bank of Taiwan

INDIA

Allahabad Bank
Andhra Bank
Bank of Baroda
Bank of India
Bank of Maharashtra
Bank of Rajasthan
Canara Bank
Central Bank of India
City Union Bank
Corporation Bank
Dena Bank
Development Credit Bank
Dhanalakshmi Bank
Federal Bank
Hdfc Bank
ING Vysya Bank
Icici Bank
Industries Bank Housing
Indian Overseas Bank
Idbi Bank
Indian Bank
Jammu and Kashmir Bank
Karnataka Bank

Karur Vysya Bank
Indusind Bank
Oriental Bank of Commerce
Punjab National Bank
South Indian Bank
State Bank of India
Lakshmi Vilas Bank
State Bank of Bikaner and Jaipur
Prime Securities
Syndicate Bank
UCO Bank
Union Bank of India
Axis Bank
State Bank of Mysore
State Bank of Travancore
Vijaya Bank
Yes Bank

INDONESIA

Bank Artha Graha Internasional
Bank Bukopin
Bank Bumi Arta
Bank Bumiputera Indonesia
Bank Central Asia
Bank Capital Indonesia
Bank Mutiara
Bank Danamon Indonesia
Bank Eksekutif Internasional
Bank International Indonesia
Bank Kesawan
Bank Ekonomi Raharja
Bank Mandiri
Bank Mayapada Internasional
Bank Mega
Bank Negara Indonesia
Bank Cimb Niaga
Bank Windu Kentjana
Bank OCBC Nisp
Bank Nusantara Parahyangan
Bank Per Annum Indonesia
Bank Permata
Bank Rakyat Indonesia
Bank Swadesi
Bank Victoria International
Bank Tabungan Pensiunan Nasional
Bank Himpunan Saudara 1906

MALAYSIA

Affin Holdings
AMMB Holdings
Bimb Holdings
Cimb Group Holdings
EON Capital
Hong Leong Bank
Hong Leong Financial Group
Malayan Banking
Alliance Financial Group
Public Bank
RHB Capital

PAKISTAN

Meezan Bank
Allied Bank
Arif Habib Bank
Askari Bank
Atlas Bank
Bank Al Habib
Bank Al-Falah Limited
Bank of Khyber
Bank of Punjab
Bankislami Pakistan
First National Bank Modaraba
Samba Bank
Faysal Bank
First Credit and Investment Bank
Habib Bank
JS Bank Limited
Kasb Bank
MCB Bank
Mybank
Habib Metropolitan Bank
National Bank of Pakistan
The Royal Bank of Scotland
Network Microfinance Bank
NIB Bank
Silkbank
Soneri Bank
Standard Chartered Bank (Pakistan)
United Bank

SRI LANKA

Capital Reach Leasing
Commercial Bank of Ceylon
Dfcc Bank
Hatton National Bank
Housing Development Finance Bank
Merchant Bank
National Development Bank
Nations Trust Bank
Per Annum Asia Bank
Sampath Bank
Peoples Merchant Bank

Seylan Bank
Seylan Merchant Bank
Vanik Incorporation

THAILAND

Bangkok Bank
Bank of Ayudhya
Cimb Thai Bank
Kasikornbank
Kiatnakin Bank
Krung Thai Bank
Siam City Bank
Siam Commercial Bank
Thanachart Capital
TMB Bank
Tisco Financial Group

ARGENTINA

Banco Galicia 'B'
Banco Macro 'B'
Banco Rio 'B'
BBVA Banco Frances 'B'
Bpat
Grupo Financiero Galicia 'B'
Hipotecario 'D'

BRAZIL

ABC Brasil PN
Amazonia ON
Alfa Invest PN
Santander BR PN
Banco Brasil ON
Itauunibanco PN
Banco Minas Preference
Banese PN
Banestes ON
Banpara ON
Banrisul PNB
BRB Banco PN
Bicbanco PN
Bradesco PN
Cruzeiro Sul PN
Daycoval PN
EST Piaui ON
Merc Brasil PN
Merc Invest PN
Nossa Caixa ON
Indusval PN
Nord Brasil PN
Pine PN
Parana PN
Sofisa PN
Panamericano PN

CHILE

Bbvacl
BCI
Bsantander
Chile
Corpbanca
SM-Chile 'B'
Sudamer 'A'

COLOMBIA

Bbvacol
Bogota
Bcolombia
Santander
Colpatria
Pfhelmbank
Grupoaval
Popular
Occidente
PF91DAVIVI
Villas

MEXICO

Banca Quadrum Sponsored ADR 1:1
GBM 'O'
Compart 'O'
Gfinbur 'O'
Finamex 'O'
Gfnorte 'O'
Ixegf 'O'
Sanmex 'B'

PERU

ADCOMEC1
CONTINC1
BANCOMC1
INTERBC1
BANFALC1

CSCOTIC1
BRIPLEC1
CREDITC1
SCOTIAC1
FINANCC1
Incatrk
MIBANC1
NCFC1

VENEZUELA

Banco Canarias de Venezuela
Banco Caribe 'A'
Banco Confederado
Banco de Venezuela
Banco Exterior
Banco Activo Banco Comercial
Banco Nacional de Credito
Banco Occidental de Descuento Banco Universal
Banco Provincial
Banesco Banco Universal
Bannorte
Central Banco Universal
Corporation Banca
Fondo Comun CA Banco Universal
Inverunion Banco Comercial
Fivenez Banco Inversion
Mercantil Servicios Financieros 'A'
Venezolano de Credito